PLASTICS

THE MAGAZINE OF APPLIED ENGINEERING

TECHNOLOGY

May 1959

Facts on 1959 injection molding machines and auxiliaries

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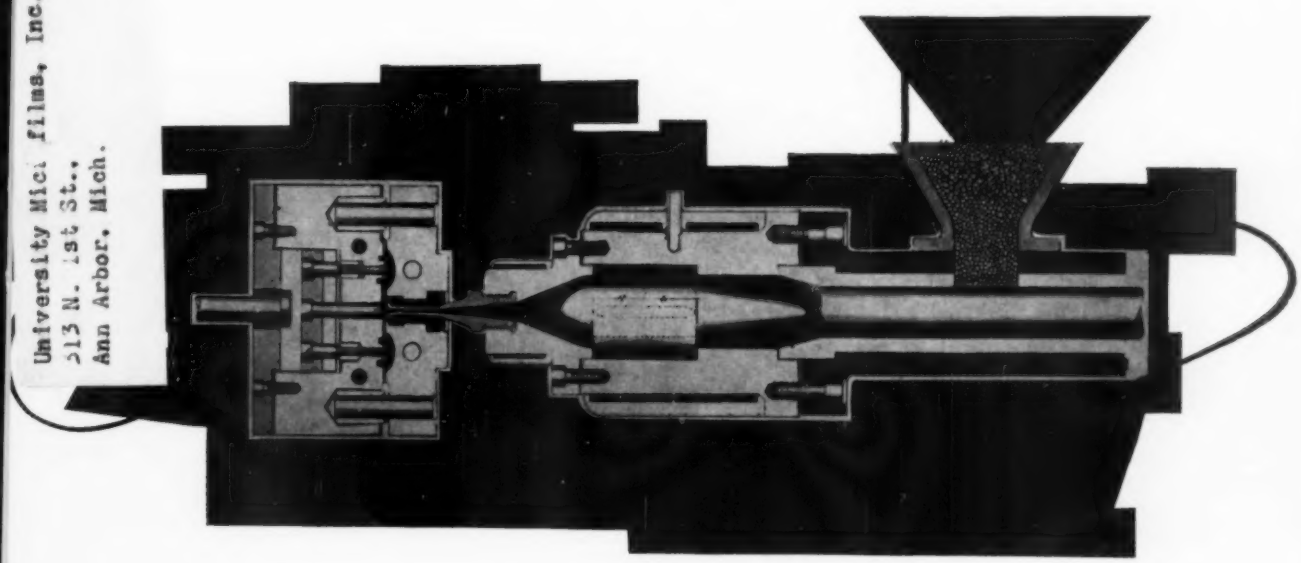

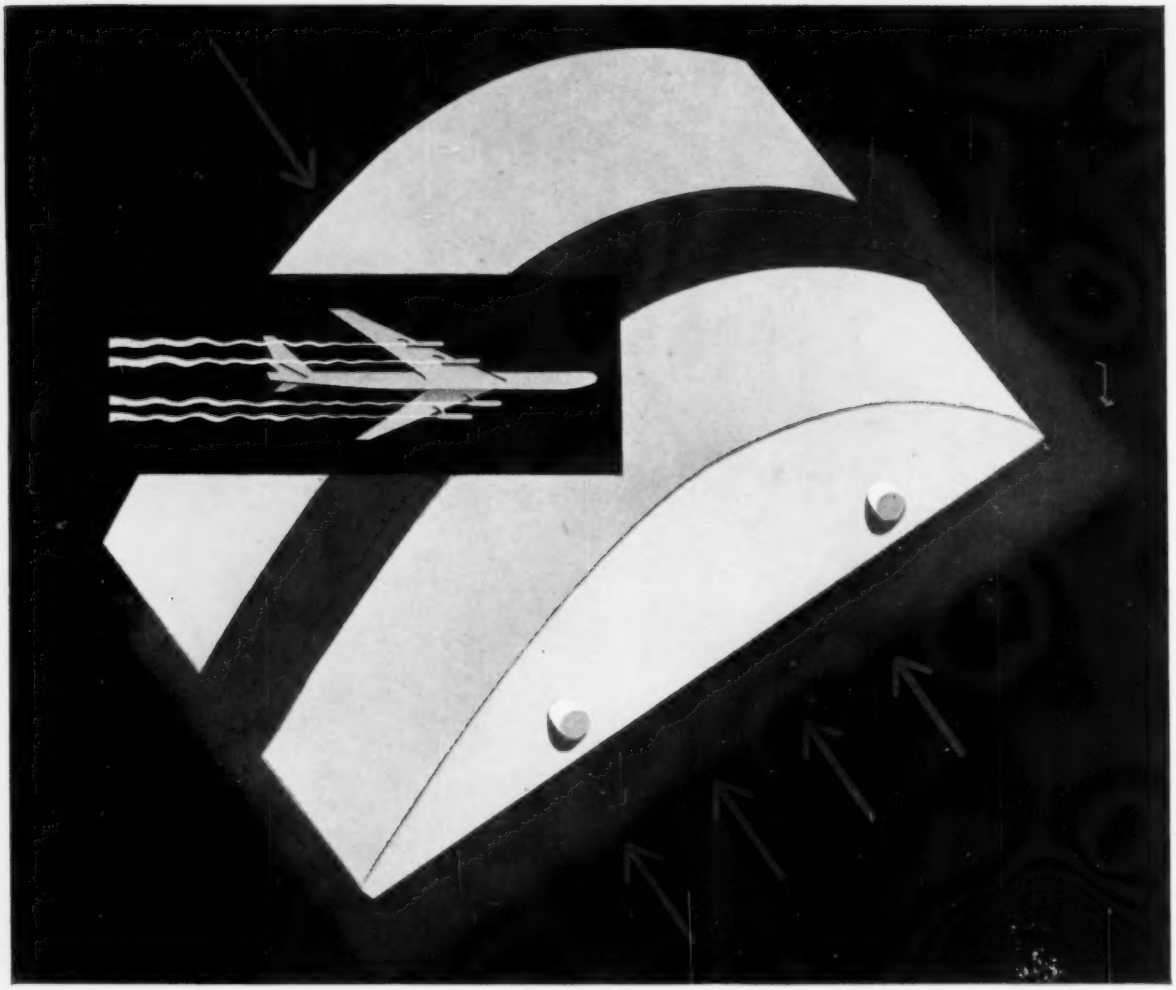

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THE MAGAZINE OF APPLIED ENGINEERING

TECHNOLOGY

MAY 1959 VOLUME V NUMBER 5

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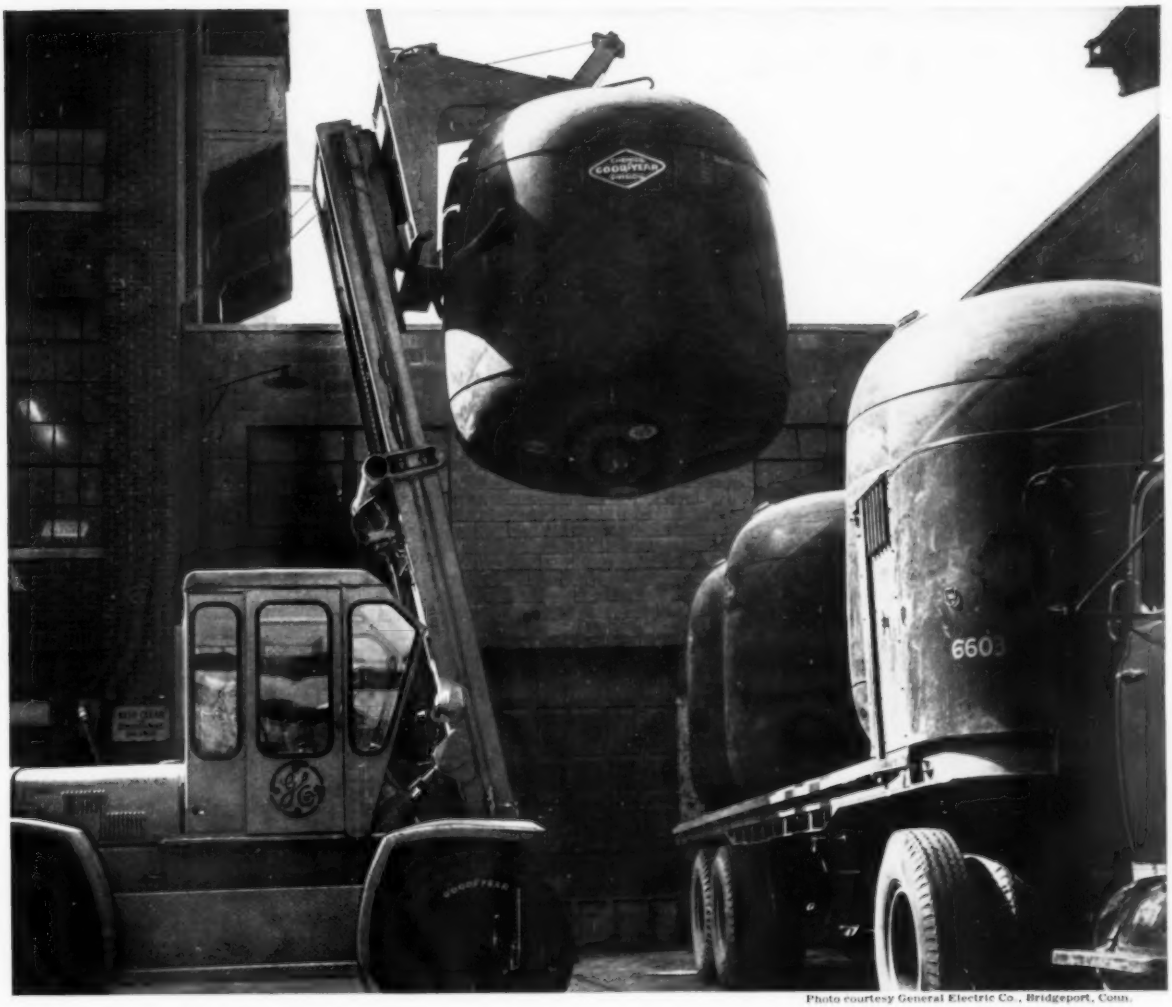

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Letters to the Editors

Previews of Next Month

The June issue will feature the following articles:

Rigid Urethane Foams. Dr. Antoine Khawam, Technical Director, Industrial Plastics Div., The Englander Co., Baltimore, Md.

A discussion and comprehensive review of polyurethane foams to date. Topics covered include basic urethane chemistry, foam formulations, foam preparation, chemical and physical properties of the foams, and both current and potential applications for the foams in industry.

•

Some Tensile Properties of Cellulose Acetate Butyrate. R. E. Ely, Research Engr., Ordnance Missile Labs., Army Rocket and Guided Missile Agency, Redstone Arsenal, Huntsville, Ala.

Results are given for an investigation of tensile properties over seven decades of stress rate covering a wide range of testing speeds and temperatures. Crosshead speeds ranged from relatively "static" values to several thousand inches per minute, using a special high-speed testing machine.

•

Selecting the Proper Marking Process for Plastics. H. O. Bates, Founder, and W. A. Heine, Jr., Gen'l Mgr. & Ch. Engr., The Acromark Co., Elizabeth, N. J.

A technique for proper selection of the process to be used for specific plastics materials and products made therefrom is presented. Advantages, limitations, and possible draw-backs for the system are discussed in detail. Marking equipment for hot-stamping of thermoplastic materials is described in terms of basic types.

•

Factors Influencing Durability of Glass Reinforced Polyesters. A. L. Smith, Head, and J. R. Lowry, Engr., Reinforced Plastics Applications Lab., Rohm & Haas Co., Bristol, Penna.

Considerable differences exist in performance of polyester resins on outdoor exposure. Data are given for performance of both specially-designed and conventional resins. Theories are proposed on differences exhibited, and to relate certain properties to erosion and fiber prominence.

Suggested Correction

Dear Sir:

We appreciate the fine way in which you have presented the text of our paper, "Optical Properties of Translucent Glass Reinforced Panels," in the March 1959 issue of PLASTICS TECHNOLOGY (p.42-49).

Although the text is well done, some of the wording and data in the Tables are in error. In Table 1 (p.45), you have left out the phrases "contains 20% styrene" in the heading of the first column, and "contains 20% MMA" in the heading for the second column. These percentages are important to the reader in interpreting the data.

In Table 2 (p.46), for Inhibitor, mention could be made that the materials are IC-1027-2 and IC-420-2. For Light Stabilizer G_0 is the type used in IC-420-2 and IC-1027-2, and G_1 is the type used in IC-420-1 and IC-1027-1.

In Table 3 (p.46), under Color Purity of Transmitted Light, %, Contrast H should be +.5. Under SPI Cure Time, minutes, the Average value should be 5.59; factor B is —0.14; factor C is —0.34; factor D is —0.35; factor E is 1.28; and factor F should be blank.

Finally, the note printed at the bottom of Table 3 applies to only the first 12 properties (through Unreinforced Sheet Color).

J. B. Crenshaw, Devel. Engr.,
Comm'l Resins Development Lab.,
Finishes Division,
Interchemical Corp.
Cincinnati, Ohio

(The "omissions" in Tables 1-2 were made deliberately to avoid undue repetition of IC designations. Another correction for Table 3 is made in the "Errata" published in this issue (p. 73).—Editor)

• • •

Pearlescent Pigment

Dear Mr. Zukor:

In the February issue ("Letters to the Editor," p.4) we notice where you mention two additives for heat absorption qualities for polyester-fiberglass panels. You mentioned a pearlescent pigment to be applied either before or after fabricating the panels.

We would appreciate your advising us who manufactures this pearlescent pigment, and if you think it could be added to the panels as we make them. In other words, could we add it to the polyester resin itself? If you have any other information concerning such heat absorption material, we would appreciate receiving it very much.

N. W. Dockery, Pres.
Dockery Mfg. Co.
Rockingham, N. C.

(The pearlescent pigment can be added directly to the polyester resin mix prior to fabrication. At present, tests are being run to evaluate the heat absorption properties of specially-prepared polyester panels. Information on this is not available as yet. I have taken the liberty of passing along your request for information to the pigment manufacturer, Rona Laboratories, Inc., Bayonne, N. J., who will contact you in the near future to supply you with samples and more information. —L. J. Zukor, Engineering Editor)

• • •

Tantalum-Coated Carbon Heaters

Dear Mr. Zukor:

We have read with interest your January article on Continuous Metallizing.

Would it be possible for you to inform us of the supplier of the tantalum-coated carbon heaters and/or who we can contact to learn more of the details of this system? We would be very interested in evaluating it for our purposes.

L. A. Peterson, Mfg. Supt.,
Stimsonite Div., Elastic Stop
Nut Corp. of America
Chicago, Ill.

(Tantalum-coated carbon heaters are available only under license agreement with the patent holder, National Research Corp. Lee Zukor passed this request on to NRC for their direct reply.—Editor)

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation and address.

A letter will not be printed if publication is not desired by the sender, and the identity of the writer will be withheld, if desired.

—The Editor

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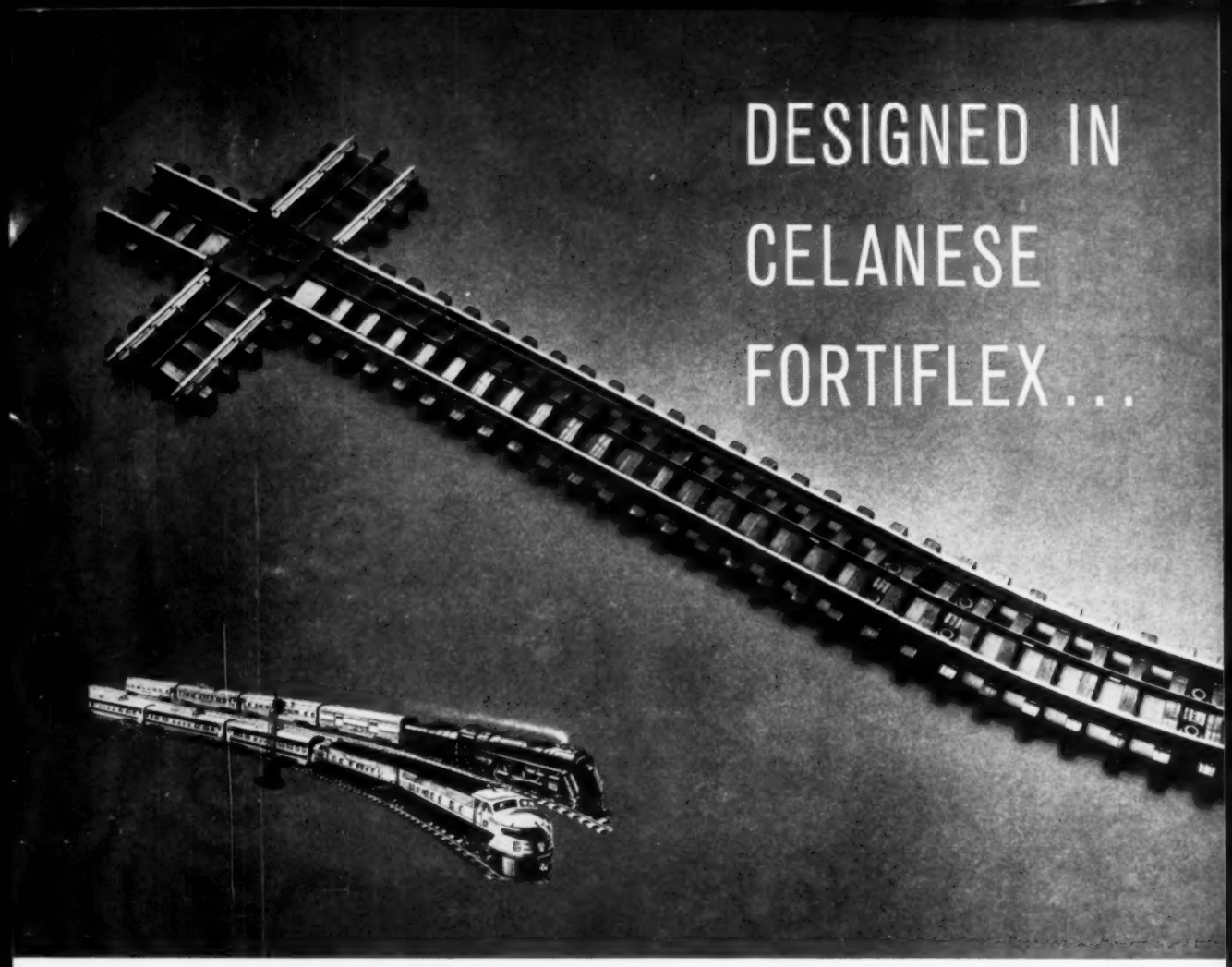

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Heat Distortion Temp. (66 psi)	D-648-45T	°F.	185	185	180	180
Brittleness Temp.	D-764-52T	°F.	—200	—180	—160	—100
Impact Strength, Izod (⅛" x ½" injection-molded bars)	D-256-54T	ft. lb./in. notch	23	18	13	3
Tensile Strength, Max., 0.2 in./min.	D-638-52T	psi.	3700	3600	3500	3300
Elongation, First Tensile Yield Point	D-638-52T	%	25	25	25	25

Properties of Fortiflex "A" Not Affected by Melt Index

PHYSICAL PROPERTIES	ASTM METHOD	UNITS	VALUE
Density		g./cc.	0.96
Refractive Index	D-542-50	n_D^{25}	1.54
Hardness, Shore D	D-676-49T		65
Stiffness	D-747-50	psi.	150,000
Water Absorption (⅛" specimen, 24 hr. immersion @ room temp.)	D-570-54T	%, wgt. gain	<0.01
Flammability	D-635-44	in./min.	1.0
*Mold Shrinkage length		in./in.	0.03 to 0.05
width		in./in.	0.02 to 0.04

*Measured on injection molded tensile bar. Mold shrinkage depends on part design and molding conditions.

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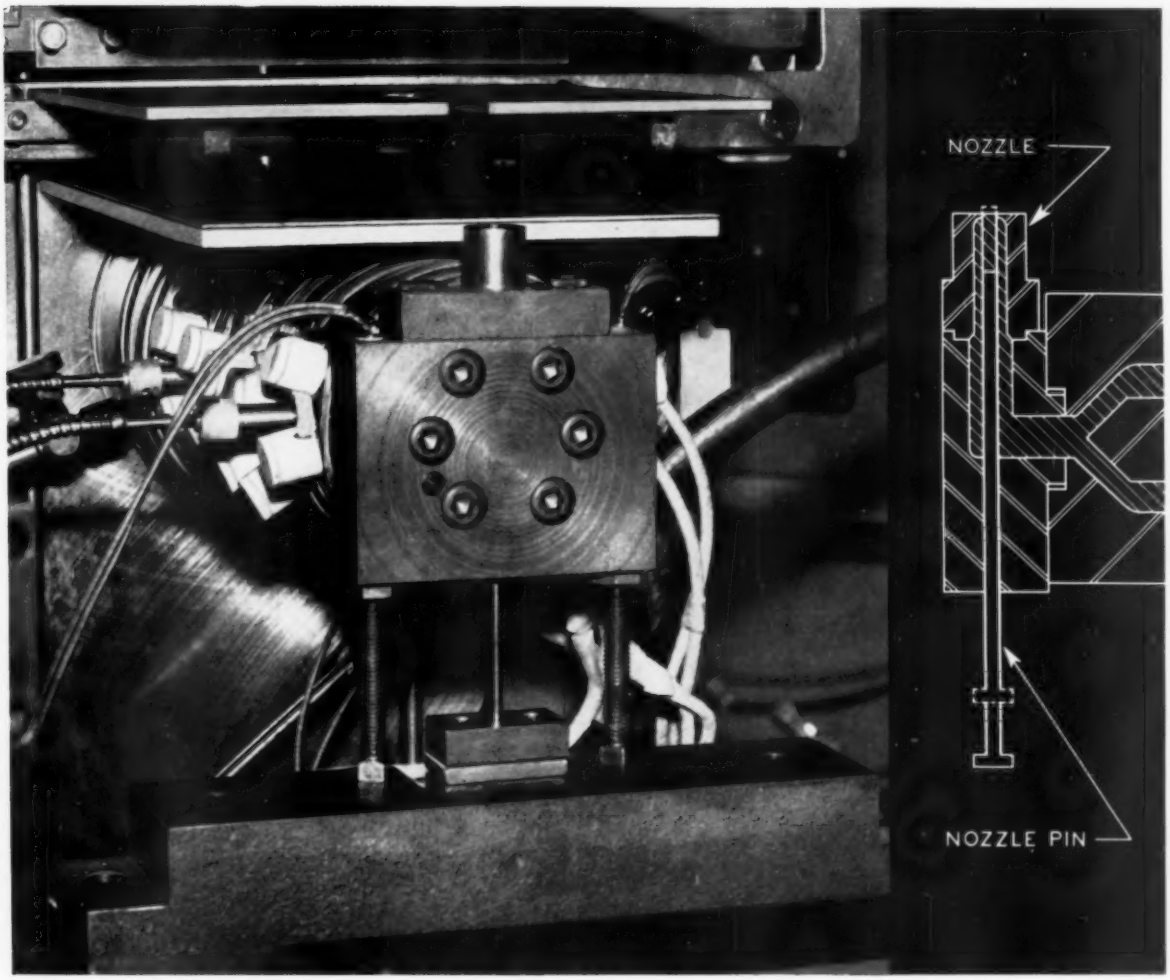

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MAY, 1959

EDITORIAL: Injection Machines & Auxiliaries

In this issue, we are proud and pleased to present a special feature section on 1959 Injection Molding Machines.

The section begins with a specially-written article on "What a Plastics Engineer Should Look For When Planning to Buy Auxiliary Equipment for Injection Molding," by Gordon Thayer, Plastics Specialist for Dow Chemical's Plastics Technical Service and a respected member of PLASTICS TECHNOLOGY's Editorial Advisory Board. Gordon's reputation and abilities are so well known that his article will surely make a deep impression.

•

Following the introductory article in this issue's special section is a lengthy, comprehensive tabulation of PT's Comparative Data on 1959 Injection Molding Machines, and a Classified List of Auxiliary Equipment.

The need for our coverage of 1959 machines arose from the many new machine models developed since our 1958 special section. That section received universal acclaim from our readers and the entire plastics industry. In fact, many thousands of reprints of the section were ordered, and we have been deluged with requests for similar coverage on the newer injection machines.

The classification system used in this issue's data tabulation is quite similar to last year's, with the incorporation of three new data categories dealing with speed of machine operation. The retention of all the other categories used in the 1958 tabulation shows the excellent progress made by injection machine manufacturers in achieving a major degree of standardization in specification features.

To avoid use of oversize pages in the magazine to cover the many machine models available, we have limited the tabulation to no more than six models per manufacturer. Those with more than this number of models have been foot-noted to indicate this.

The Classified List of Auxiliary Equipment, of course, is new for our publication, but also is something that was badly needed by the industry. What do you think of it? Next, what can we do to make future "special section issues" of more interest and value to you? We already have our own opinions, but we try to have the magazine reflect and meet the desires of its readers.

•

As a relatively long-distance preview, we can mention that work already is under way on the next special feature section that will be published in our September issue and will cover 1959 Extrusion Machines. Here, again, emphasis will be placed on auxiliary equipment, including blow molding. In addition, the data categories, and their order of consequences, used in this forthcoming tabulation have been improved over the 1958 system.

Arthur M. Merrill
Editor

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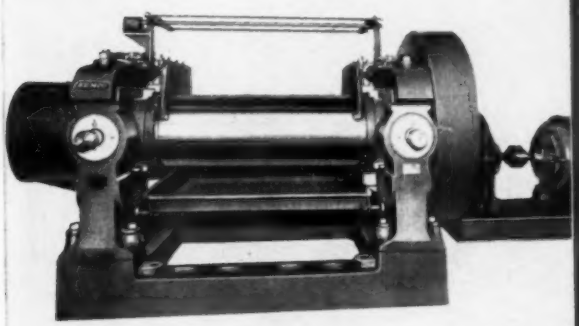

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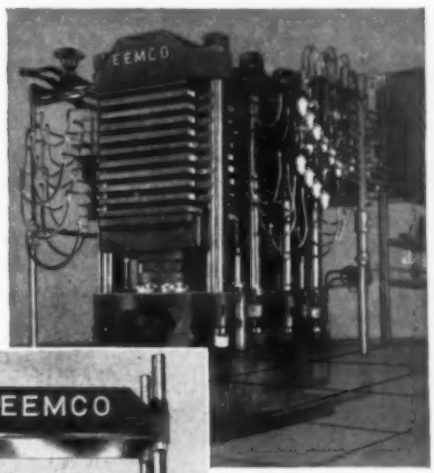

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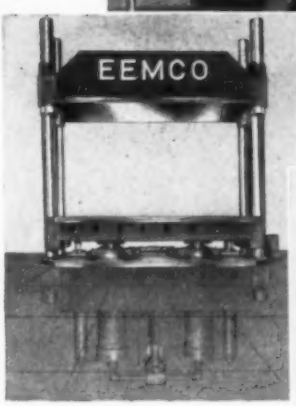

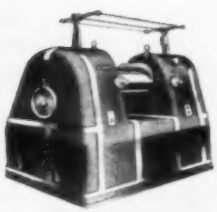

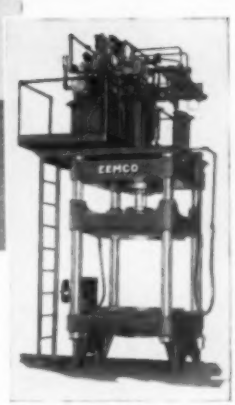

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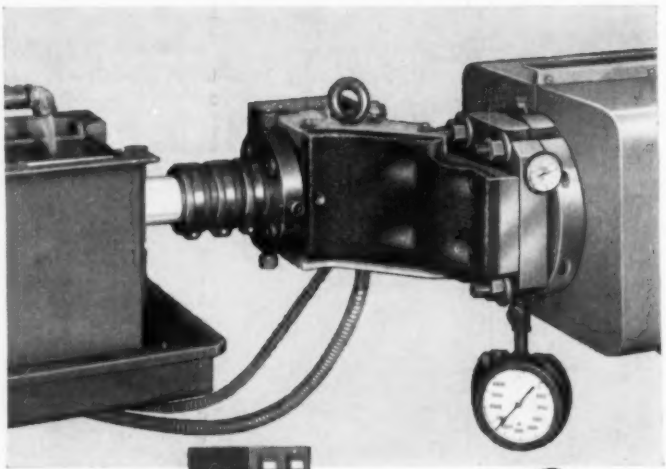
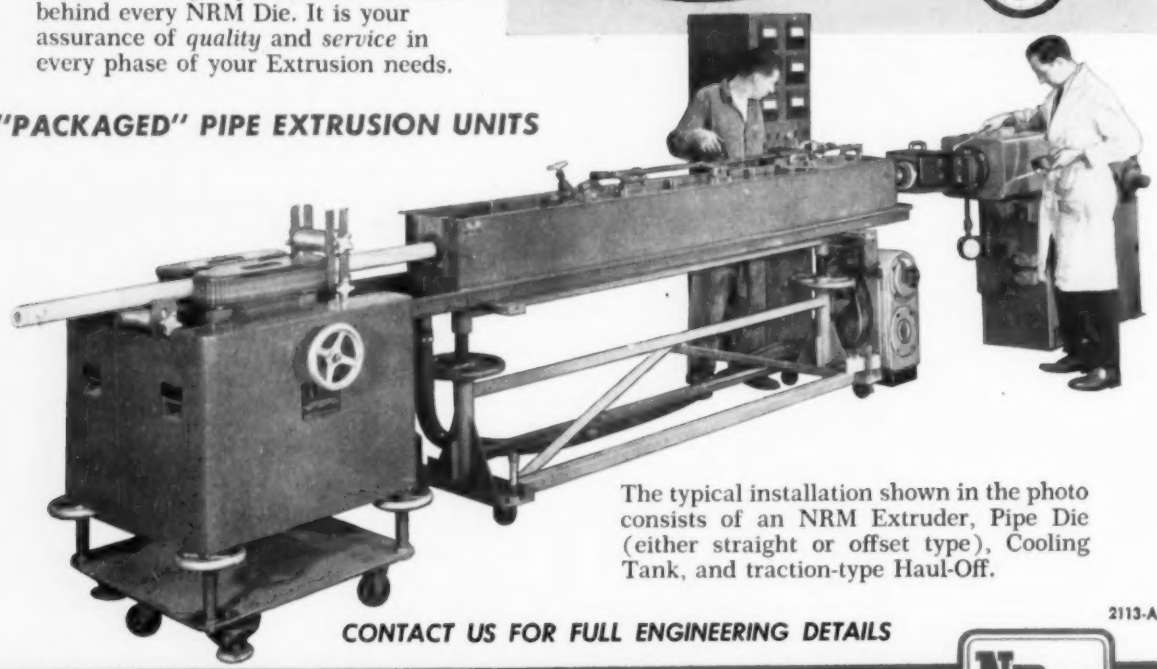
When you are considering dies for your pipe extrusion setup, consider the long background of die engineering and manufacturing experience that stands behind every NRM Die. It is your assurance of *quality* and *service* in every phase of your Extrusion needs.



"PACKAGED" PIPE EXTRUSION UNITS



The typical installation shown in the photo consists of an NRM Extruder, Pipe Die (either straight or offset type), Cooling Tank, and traction-type Haul-Off.

2113-A

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CANADIAN: F. F. Barber Machinery, Ltd., 187 Fleet St., West, Toronto, Ont.

EXPORT: Omni Products Corporation, 460 Fourth Ave., New York, N. Y.

NEWS in BRIEF

An all-reinforced plastics building will be displayed as part of the American National Exposition in Moscow, U.S.S.R. The building parts were molded by Lunn Laminates, Inc.

Business developments in the plastics industry were varied in type. American Cyanamid will discontinue manufacture and sales of its methyl-styrene-based Cymac molding compounds, effective June 1st. Hull-Standard offers to convert semi-automatic compression molding presses to fully-automatic. Koehring has acquired the complete business of Cast-Master, Inc., which will now operate as a division of the purchasing firm. NRC Equipment opened a new West Coast office in Palo Alto, Calif. Riverside Plastics purchased Bischoff Chemical Corp. from Miles Laboratories, and will make and market the Bischoff line of protective strippable coatings. Witco Chemical has merged Emulsol Chemical Corp. with the former's organic chemicals division.

Company expansions in plastics remain in the news this month. Northern Plastics plans an over-all expansion program that will include enlargement of its plant facilities and establishment of a national sales organization. Peerless Plastics has installed new machinery as the first step in its $250,000 expansion program that will increase its custom molding capacity by more than 50%. Midland-Ross Corp. has moved its J. O. Ross Engineering, Hartig Extruder, and John Waldron Corp. divisions to new and larger quarters. Seiberling is building a new plant addition in Newcomerstown, O., for its plastics division. Texas Eastman is expanding polyethylene capacity at its Longview, Tex., plant from 85-million to 100-million pounds annually. The company also will increase its aldehyde capacity to 125-million pounds per year. Union Carbide's annual capacity for low-density polyethylene is expected to reach 410-million pounds per year by this summer, as compared with current annual output of 330-million pounds. American Viscose has installed new processing equipment for its cellophane in the new distribution center for the company's film division. Carl H. Biggs moved to new and larger quarters in Santa Monica, Calif. Gulf Oil will build a new Oxo alcohols plants at its Philadelphia, Pa., refinery.

Raw materials suppliers have three responsibilities—research, production, and sales—all of which are vital for complete success, says R. V. Jones, Manager of Tech. Services & Development for Phillips' Plastics Sales Division (see Guest Editorial, page 55). These three responsibilities should be kept in balance, and doing so requires every bit of a progressive company's ingenuity. Proper technical information and services by a resin supplier does not interfere with the customers' business, techniques, and capabilities, but tries to help him by providing the benefit of the supplier's knowledge on a specific resin.

New Materials to be noted (see pages 79-81): two flame-retardant, paper-base phenolic laminates; reclaim rubber-base adhesive for plastics foams; emulsion polymerization catalyst; series of removable plastics coatings to protect high-finish parts; glass fiber-reinforced polyester molding compound; three anhydride hardeners for epoxy resins; and Teflon-impregnated glass cloth laminate for corrosive applications.

New Equipment worthy of attention (see pages 82-5): splicing machine for rigid vinyl extrusions; automatic blow molding machine; manually operated spring clamps; series of armoured ball-check valves with solid fluorocarbon molded bodies; variable-ratio dispensers for two-component systems; torsion pendulum for measuring crystallinity of fluorocarbon resins; and portable, table top vacuum molder.

Plastics Applications of special interest (see pages 86-91): two grades of epoxy-bonded fiberglass tubing; skin-diving suit of closed-cell vinyl foam; swimming pool covers of light stabilized polyethylene; reusable vulcanized fiber shipping containers padded with urethane foam; color-coded laminates for molded parts and shapes; polyethylene-coated liners for shipping containers; 21-foot long nylon calender for embossing or coating of papers and textiles; and large-size glass-polyester pontoon floats.

New! Revolutionary!

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The *slowest* LOMBARD HYDRA-PAK is 99% faster than any other standard machine — 17% faster than any special machine on the market

- **ACTUAL INJECTION RATE OVER 2400 CU. IN./MIN.**
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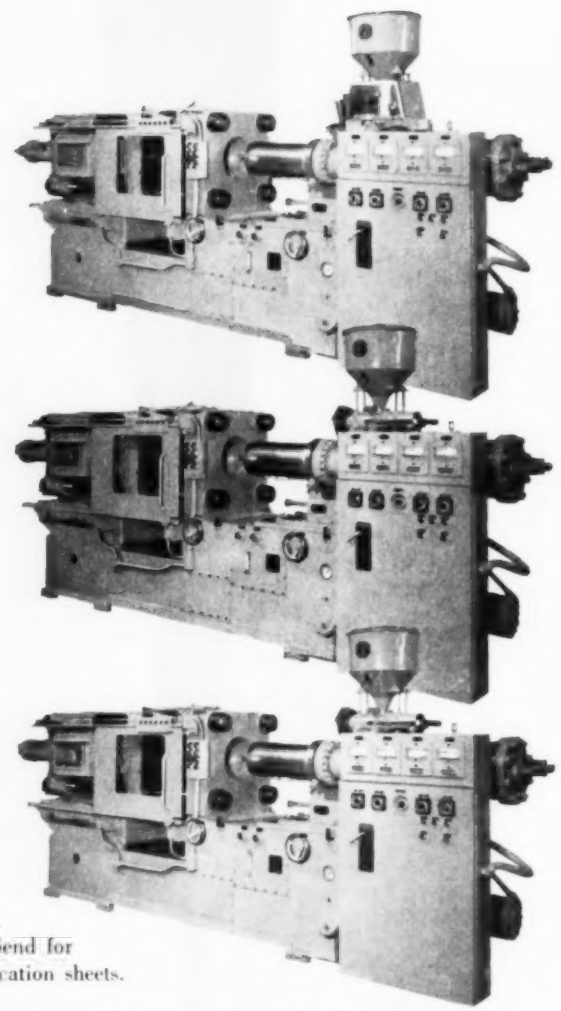
Available with any 6/9, 12/16, 16/20 or 18/24 oz. LOMBARD INJECTION MOLDERS.



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World's fastest 12/16 oz. machine.

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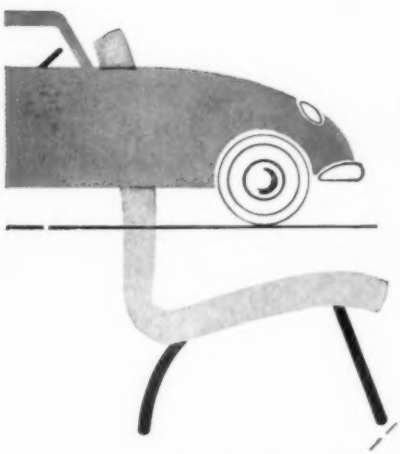

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For colorful products in rich deep tones or delicate pastel tints, use Harshaw cadmium pigments.

The chemical and heat resistance of cadmium yellows and reds combined with their complete insolubility make them excellent for use in plastics, printing inks and industrial finishes.

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In High-Density, 17 "BAKELITE" Polyethylene Compounds for New Products and Profits Like These

Check the unique, *low-to-high* density range of BAKELITE Brand Polyethylenes for your *widest selection of properties*—whatever your end-use application. Your choice covers densities from .916 up to .960—a spectrum *unequalled in the field* to let you match properties exactly to your purpose.

With "BAKELITE" *high-density* materials, properties include a range of melt

EXTRUSION COATINGS

Multi-trip bottled beverage cases

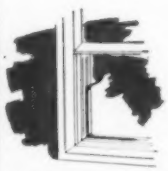
Multiwall bags and barrier papers

EXTRUSIONS

Wire and cable

Monofilaments for furniture tape

Monofilaments for rope and twine



Contour extrusions

INJECTION & BLOW MOLDING

Bottles and packaging

Housewares

Large cases and housings

Here are some of the several-score products successfully manufactured from the new "BAKELITE" Brand high-density polyethylene compounds. If there's a profit idea here for you, call your Technical Representative.

1143

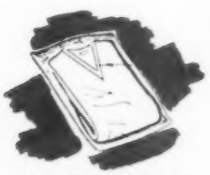
HIGH

Polyethylene from the source widest density spectrum!

TO

indexes in combination with particular qualities for molding, extrusion, coatings and film applications. High flow rates—higher rigidity — heat resistance — grease and moisture impermeability — toughness —gloss—abrasion resistance and other properties are provided "as you want them." Check your Union Carbide Technical Representative—and, for the leaflet which lists all "BAKELITE" Brand High-Density Polyethylenes write Dept. EQ-143.

FILM



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IMS Super Duty T-2D Drum Tumbler with disposable fiber drums in place. New model features special clutch and electric brake.

IMS Drum Tumblers are stocked in 5 different models

T-2
Popular Model 3/4 HP

Takes drums up to 33" high and in all diameters up to 22".

Capacity 75 to 100 lbs. Each Drum

Price complete $595.00

T-2A
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Specifications same as Model T-2 except that 1 HP motor is supplied in place of ¾ HP.

Capacity 100 to 150 lbs. Each Drum

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Takes drums up to 37" high and in all diameters up to 23¼".

Capacity 250 to 300 lbs. Each Drum

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T-2C
Extra Heavy Duty 3 HP

Takes drums up to 43" high and in all diameters up to 24".

Capacity 350 to 400 lbs. Each Drum

Price complete $1285.00

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Takes drums up to 45" high and in all diameters up to 24".

Capacity 450 to 500 lbs. Each Drum

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Complete Parts List and Operating Instructions available on request.

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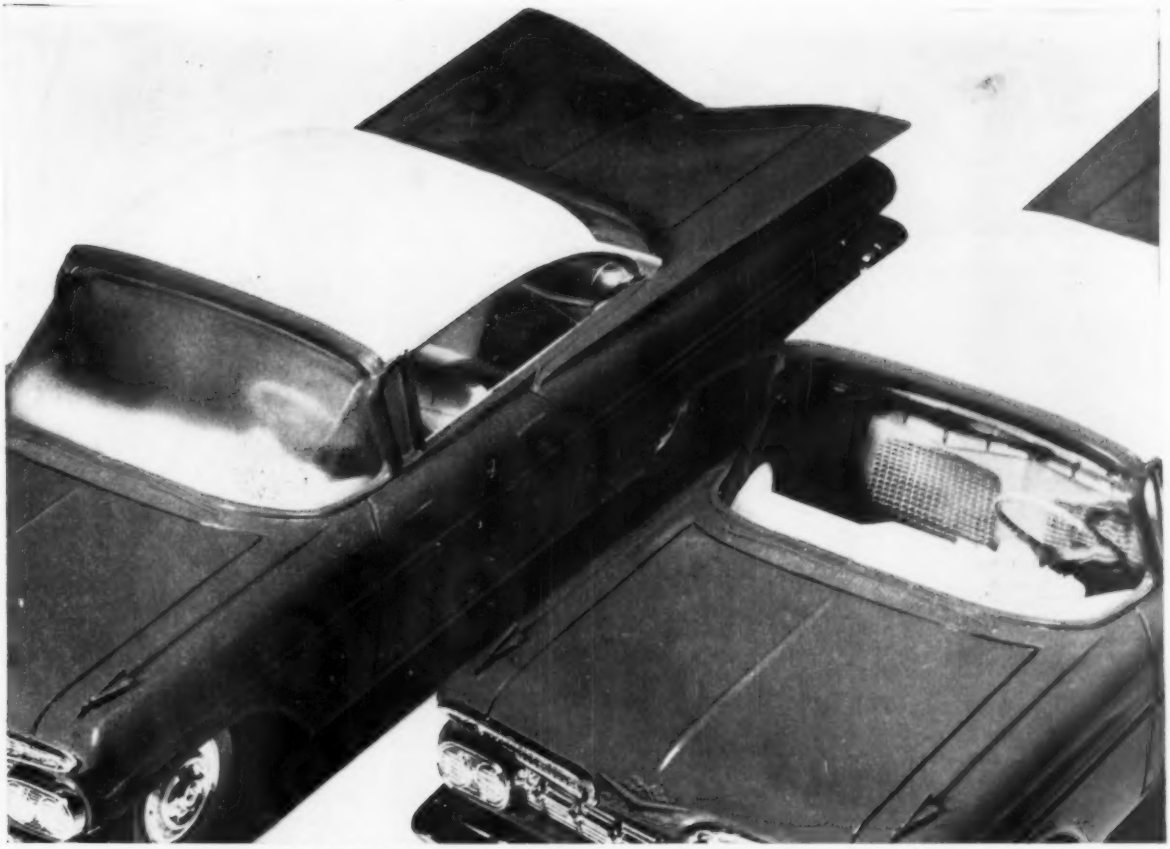

NEW "ELASTEX" PLASTICIZERS 36-R and 37-R in vinyl auto interiors will not cause windshield fog on hot days. Conventional plasticizers migrate to cloud windshield—demonstrated by model at left.

Now...longer life expectancy for vinyls

Two new polymeric plasticizers overcome the old limitations on vinyl durability, permanence, and heat resistance—without the processing and handling problems of early polymeric types

ELASTEX® Plasticizers 36-R and 37-R, two new polymeric plasticizers for use as primary agents or in blends with monomeric types, now make possible improvements in a broad range of end-product properties—longer life, reduced shrinkage, lower volatility, less migration (in vinyl tile), greater resistance to heat and solvents.

"ELASTEX" 37-R Plasticizer is a high molecular weight material designed for vinyl compounding. It enables vinyl products to withstand high temperatures and remain practically unaffected by kerosene, oil and soapy water. Suggested applications: cable jackets, paper coatings, appliance gaskets, high-grade upholstery sheeting.

"ELASTEX" 36-R Plasticizer is of medium molecular weight, developed for more general use. Combined with monomeric types, it makes an easy-to-process compound of high durability. Recommended for upholstery sheeting, coated fabric, wall covering, electrical tape and window channeling.

The resources of Allied Chemical are at your service in the application of these new "ELASTEX" Plasticizers. Take the step today that will upgrade your products tomorrow. Call your representative or write us direct for samples and technical data.

PLASTICS AND COAL CHEMICALS DIVISION
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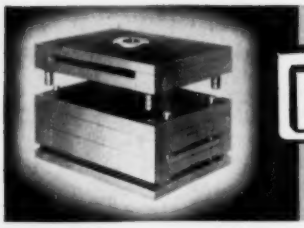
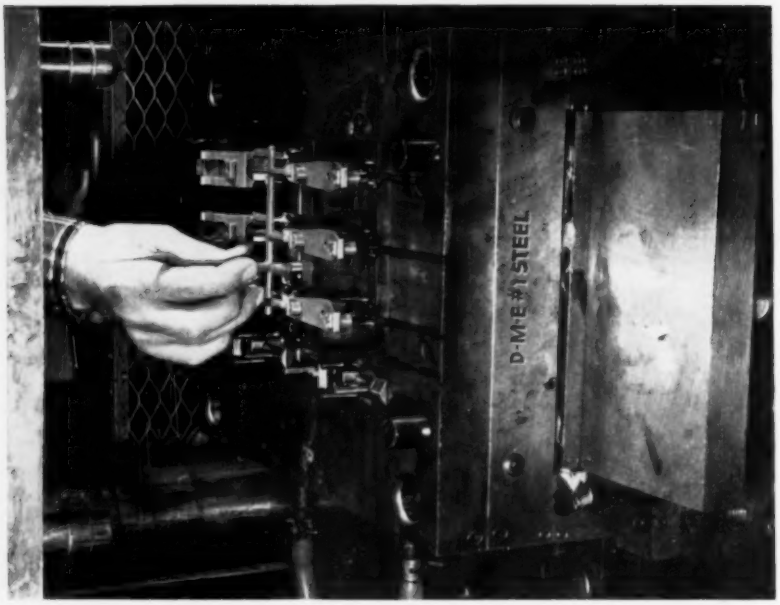


DME Mold Standards

DEDICATED TO QUALITY, SERVICE AND ECONOMY IN MOLDING



YOU SAVE MORE ON MOLD COSTS WITH OVER 6,000 D-M-E STANDARD MOLD BASES TO CHOOSE FROM

Largest Selection Saves You Time and Money

Whether it's a one-cavity "test" mold or a 60-cavity high production run, chances are D-M-E has the right size Standard Mold Base to fit the job and the molding machine.

D-M-E's 32 standard sizes, up to 23¾" x 35½", with 100 standard cavity plate combinations for each size, give you the largest selection of carbon or alloy steel standards available from any single source.

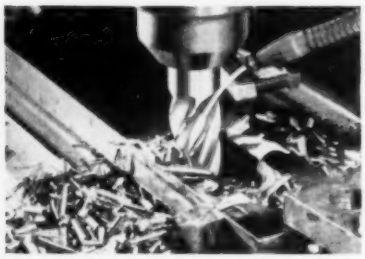
Save on Design Time, Moldmaking Time, Replacement Parts and Delivery

Design time is reduced by using D-M-E's full-scale Master Layouts and Catalog of specifications and prices. Moldmaking time is reduced because all D-M-E plates are precision ground flat-and-square, ready for cavity layout and machining. Exclusive interchangeability gives you the added saving of immediate replacement of any component part. And D-M-E's seven branch offices and warehouses are always fully stocked with Standard Mold Bases and components to meet your delivery requirements.

Cut Costs on Your Next Program

Start saving on your next moldmaking program, no matter how large or small. Take advantage of D-M-E Quality, Service and Economy.

IN LOCAL STOCK— Tools 'Tailor-Made' For Moldmakers



D-M-E's complete stock of moldmakers' tools and supplies can save you time and money! No more waiting for "special" oversize reamers to open up ejector pin holes; no more extra set-up charges. D-M-E has what you need—*in stock*.

In addition to fast-cutting End Mills, shown above, D-M-E also carries a complete stock of:

Ejector Pin COUNTERBORES

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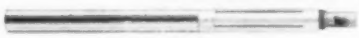
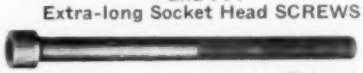


and . . .
Extra-long Socket Head SCREWS



(up to 12" long)

START SAVING NOW! Contact your nearest D-M-E Branch for full details and prices.

FASTER DELIVERIES FROM COMPLETE STOCKS

Over 1,000 D-M-E Standard Mold Bases always IN STOCK at local D-M-E Branches for IMMEDIATE DELIVERY.

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59-A

U.S.I. POLYETHYLENE NEWS

A series for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

MAY, 1959 — U.S. Industrial Chemicals Co., Division of National Distillers and Chemical Corporation — 99 Park Ave., N. Y. 16, N. Y.

Packaging Notes

Easy opening feature for poly packaging is a "DACRON" cord set into the film. The feature is available for any type of polyethylene extrusion lamination, in both roll or pouch form. The cord can be imbedded in the surface of the poly coating, or placed between the poly coating and the material to which the polyethylene is applied. Pouches can also be fabricated with the cord sealed into the side seals of the pouch.

The cord feature is said to be especially suited to packages for cheese, meat, all kinds of dry products, cocoa powders, drink mixes and heat-in-the-pouch items.

Carrots are being marketed in full color, gravure printed poly bags. Appetizing illustrations appear on the face of the bags, along with smaller vignettes and recipes on the back. The bags are said to be the first in the produce field to be printed horizontally.

Universal polyethylene drum is designed to nest inside standard 15 gallon steel or fiber drums. The polyethylene container holds a full 15 gallons and is available with a variety of closures, from standard pipe or buttress threads to external cap closures.

The new drum nests and locks when stacked, needs no pallets. The poly drum is light in weight, unbreakable and carries low freight rates.

A dozen small pockets heat-sealed from a single sheet of polyethylene form a hanging point-of-purchase merchandiser for phonograph needles. The pockets, heat-sealed on three sides, are open at the top for easy removal of the packaged needles. The pocketed polyethylene sheet is stapled to a printed hang card. As the merchandise is sold, the pockets can be restocked. The display is especially suitable for small products that might otherwise be lost or subject to pilferage.

New packaging machine is said to be able to overwrap up to 75 boxes per minute with polyethylene. The machine can also feed, cut and seal a variety of packaging materials. It can handle units three to eight inches wide and a half inch high. Special machine design is necessary for five to nine inch widths. The machine accommodates packages 4¾ to 12½ inches long.

New U.S.I. Polyethylene Plant on Stream: Capacity 75,000,000 lbs. per Year

Plans Already Underway To Double Capacity

A second plant to produce U.S.I. PETROTHENE polyethylene has just gone on stream in Houston, Texas. Capacity of the plant — 75,000,000 pounds per year of low and intermediate density polyethylene resins — increases U.S.I.'s polyethylene production capacity to 175,000,000 pounds per year. The company's other plant, at Tuscola, Ill., now has a 100,000,000-pound-per-year capacity.

Immediate Expansion planned

Along with the announcement that the plant was in operation, U.S.I. also made public plans to double the capacity of the plant by the end of 1960. This would bring the company's PETROTHENE production in the Houston area to a total of 150,000,000 pounds of polyethylene.

The location of the new plant is especially well suited for improved customer service. The Houston Ship Canal permits shipment by barge. All other means of transportation are readily available. Export shipments will be expedited through use of the extensive port facilities in Houston.

The staff for the Houston plant includes Byron J. Anderson, Plant Manager; Eugene C. Carlson, Technical Superintendent; T. Howard Dantzler, Superintendent of Operations; and E. P. Richards, Chief Engineer.

Wide Range of Resins Available

The new plant, which is already shipping commercial quantities, was rushed to completion some six to eight weeks ahead of schedule when demand for U.S.I. PETROTHENE resins began to outrun supply late in 1958. The plant uses a modification of the conventional high-pressure process already proved in the Tuscola plant. Low density (.915-.924) as well as intermediate density resins (.925-.929) are being produced. These are the polyethylene materials commonly marketed as packaging film, garment bags, squeeze bottles, wire and cable coatings and housewares.

In all, PETROTHENE polyethylenes are available in some 70 different resins, each varying in melt index, density, strength, clarity, gloss, slip, stiffness, and other properties. This wide range of resin properties is a result of U.S.I.'s program of tailor-making resins to meet specific molding and extrusion requirements.

New Expansion Will Make U.S.I. 2nd Biggest Producer

When the current expansion program is completed late in 1960, U.S.I. will become the country's second largest producer of polyethylene resins. The new capacity will raise total production of PETROTHENE resins to 250 million pounds.

U.S.I.'s growth in the polyethylene field has been spectacular. Starting with a production capacity of 26 million pounds in 1955, the company will have realized a 900% increase in production when the expanded facilities go on stream.

Along with this growth has gone technical leadership in the field of polyethylene processing, particularly in packaging film. Recently, U.S.I. pioneered a new technique for producing crystal-clear cast poly film that is finding extensive application in large volume overwrap and bread wrap markets. While U.S.I. has specialized in low and medium density resins, it has done extensive research work on a new process for making high density polyethylene. The process is said to be superior to any now in use. U.S.I. also has studied the polypropylenes and other polyolefin copolymers in pilot plant operations.

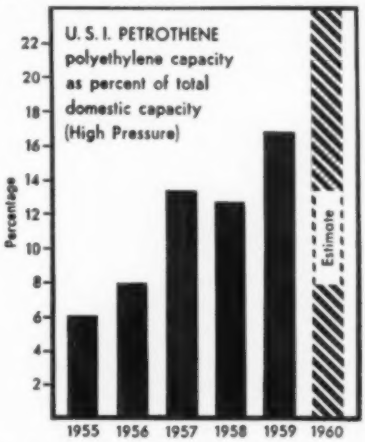

Chart shows spectacular growth of U.S.I. in polyethylene field. Starting as a non-producer less than four years ago, U.S.I. will produce almost one fourth of total U. S. high pressure polyethylene by 1960.

DO YOU HAVE a new polyethylene packaging development you'd like the industry to know about? Make it routine to send your information on new developments to U.S.I. POLYETHYLENE NEWS.

Address the Editor,
U.S.I. POLYETHYLENE NEWS, U. S. Industrial Chemicals Co., Division of National Distillers and Chemical Corp., 99 Park Avenue, New York 16, N. Y.

U.S.I.

Vol. IV, No. 3

POLYETHYLENE PROCESSING TIPS

FACTORS AFFECTING PERMEABILITY OF POLYETHYLENE

Polyethylene is highly impermeable to many liquids and gases. This property is one of the main reasons for polyethylene's widespread use in packaging.

In films and coatings, polyethylene is most often employed as a moisture barrier. It either protects materials from unwanted moisture or prevents loss of irreplaceable moisture from packaged products such as vegetables and meat. At the same time, some degree of permeability to oxygen and carbon dioxide allows leafy vegetables to "breathe."

As a liner for containers and in tubes and bottles, polyethylene's impermeability to numerous organic and inorganic chemicals accounts for its use with countless products – e.g., battery acid, brake fluid, acetone, ethyl alcohol, mustard, catsup, shampoos, detergents, hypochlorite bleach, and adhesives.

Continued development of new packaging applications depends on molders, extruders and manufacturers having a sound understanding of factors affecting the permeability of polyethylene.

Material To Be Packaged

Polyethylene's effectiveness as a barrier depends primarily on the material to be contained. As a broad generalization, the rule of "like permeates like" applies. Hence, polyethylene, a non-polar material, is only very slowly permeated by polar substances. As polarity decreases – and the contained substance more closely resembles polyethylene in structure – permeability increases.

Often not enough is known about the composition of a product to predict permeability behavior. Usually it is advisable to conduct tests, especially for doubtful materials. Cosmetics formulated with essential oils, for example, are frequently troublesome.

The vapor pressure of the contained fluid is important because the amount of a fluid or vapor passing through the barrier increases with its vapor pressure. Both vapor pressure and total gas pressure increase with temperature, so permeability tests of products such as aerosols should be run at the maximum storage temperature likely to be encountered.

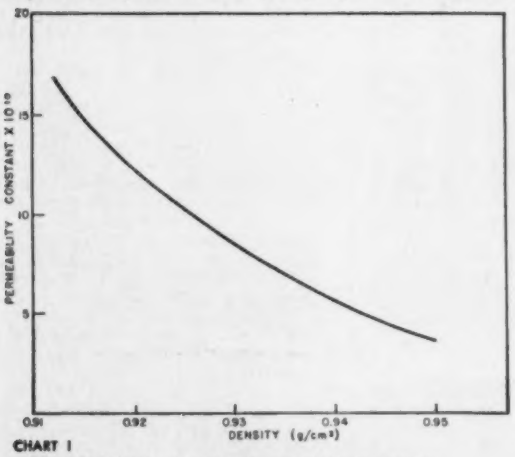

CHART I

Effect of polyethylene density on its permeability to nitrogen.

Effect of Polymer Density

Density is the basic property of polyethylene that affects permeability. As is shown for nitrogen in Chart I, permeability decreases with increase in polymer density. Increased crystallinity of the denser polymer is primarily responsible for this effect.

Effect of Processing Conditions

Permeability is affected adversely by improper processing conditions. Conditions causing non-uniform wall thickness or pinholes in the finished product naturally reduce the effectiveness of the barrier. Oxidation of polyethylene, generally brought about by subjecting it to excessive temperatures over prolonged periods of time, increases its permeability to polar compounds such as water and alcohols.

Pinholes are caused by moisture, resin degradation and air entrapment during fabrication. They can be minimized by keeping the molding powder dry and by holding extrusion temperatures within recommended limits. Often, difficulty with pinholes occurs in forming the parison in bottle blowing. Raising the temperature and increasing back pressure will frequently correct this condition.

Oxidation can be minimized by reducing extrusion temperature and by charging the machine with a special resin prior to shutdown. U.S.I.'s PETROTHENE® 205-1 Shutdown Resin, which withstands exposure at high temperatures, is recommended. Blanketing the hopper and die areas with an inert gas such as nitrogen also reduces oxidation. In blow molding, blowing with nitrogen has the same desirable effect.

Additives may modify polyethylene's permeability. Adding an inert material such as wax may enhance barrier properties provided the added material increases the density and doesn't destroy other essential properties. Other additives, such as aluminum powder, might decrease permeability by increasing the path that molecules of the contained material must traverse through the resin.

Postforming operations can also be useful. Coating with other polymers such as vinyls or vinylidene chloride offers one means of decreasing permeability. Irradiation, too, generally reduces permeability of all substances through polyethylene.

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Each polyethylene packaging application poses special permeability problems requiring a specific solution. The safest approach is to call on U.S.I.'s experienced technical service engineers. They can recommend an appropriate PETROTHENE polyethylene resin for your application and help you establish the best processing conditions.

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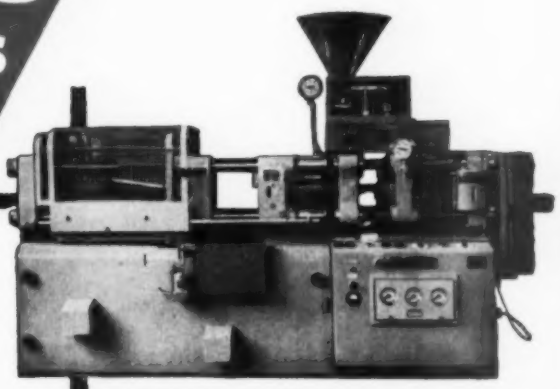

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DOW Plastiatrics

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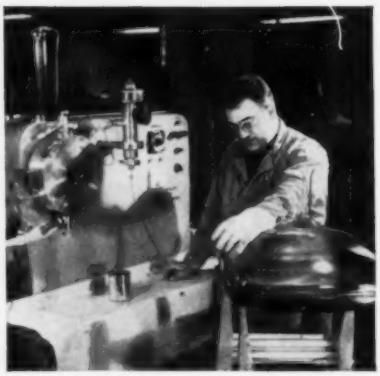
DOW DEVELOPMENT CAPITALIZES ON EPOXY'S GLASS ADHESION, STABILITY, CLARITY

A leading TV tube manufacturer recently presented Dow with a problem involving the laminating of glass panels. They had developed an advanced design for a square-face TV tube which required the laminating of a contoured implosion safety panel directly to the face of the tube. The design would provide greater safety against implosion, produce a brighter picture, eliminate the conventional, dust-catching, separate safety panel and permit the building of slimmer sets. To accomplish this, the manufacturer required a special laminating system and resin material which would meet the following requirements:

1. The method must be adaptable to mass production.
2. The method must provide a stable, adhesive bond to glass.
3. The resulting laminate must be able to withstand rough handling.
4. The resulting laminate must be able to withstand extreme changes in humidity and temperature.
5. Resulting optical properties must be acceptable by E.I.A. color standard for television.



Because no available resin met all these requirements, Dow had to develop a special system which would solve the problem.

Dow's prior extensive research and development work on epoxy resins, coupled with Dow's basic raw material position, had produced new resins whose properties appeared to offer promise of fulfilling the stated requirements. Among these resins were several which were known to: provide high-strength bond to glass; produce stable, heat-and-shock resistant laminate interlayer; exhibit nearly water-white clarity after cure; cure quickly at relatively low temperatures.

Working closely with TV engineers and manufacturers of automatic blending and dispensing equipment, Dow chemists and technical service engineers tailored a unique epoxy system which met every requirement for successful mass production of the new square tube.

Plastiatrics studies, like the one described above, are part of a continuing program by Dow Coatings Technical Service engineers to aid Dow customers in the selection of coatings materials, and in technical matters relating to manufacturing techniques. For more information on Plastiatrics studies, write THE DOW CHEMICAL COMPANY, Midland, Mich., Plastics Sales Dept. 2377DT5.

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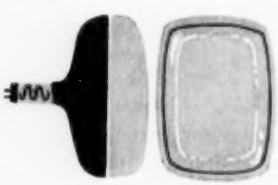

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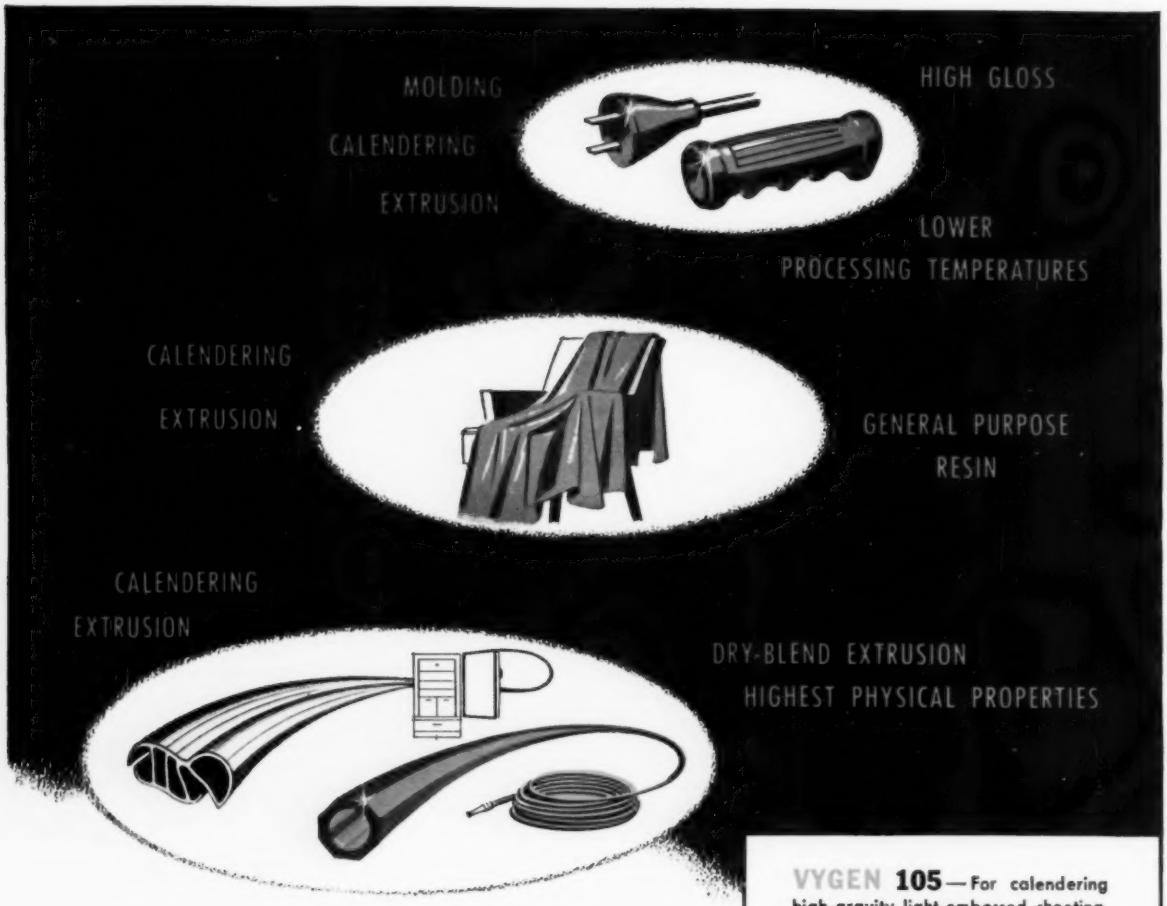

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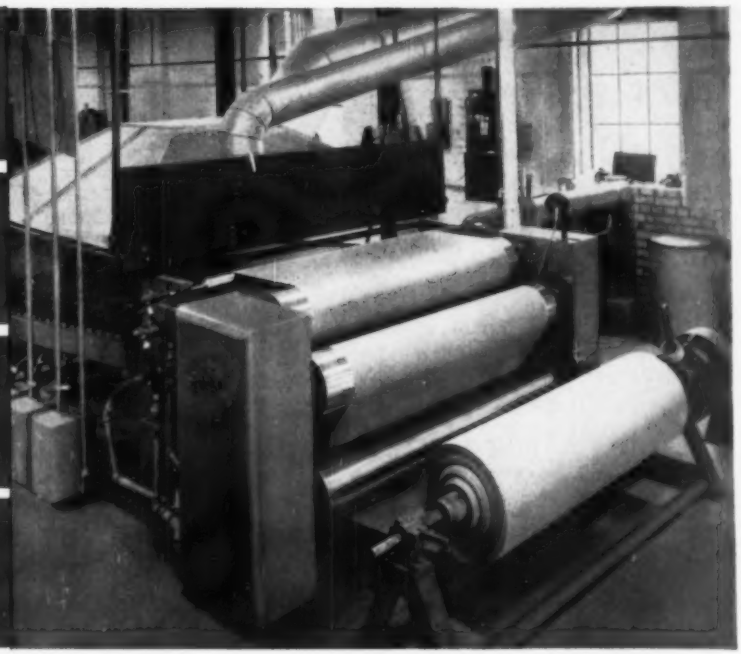

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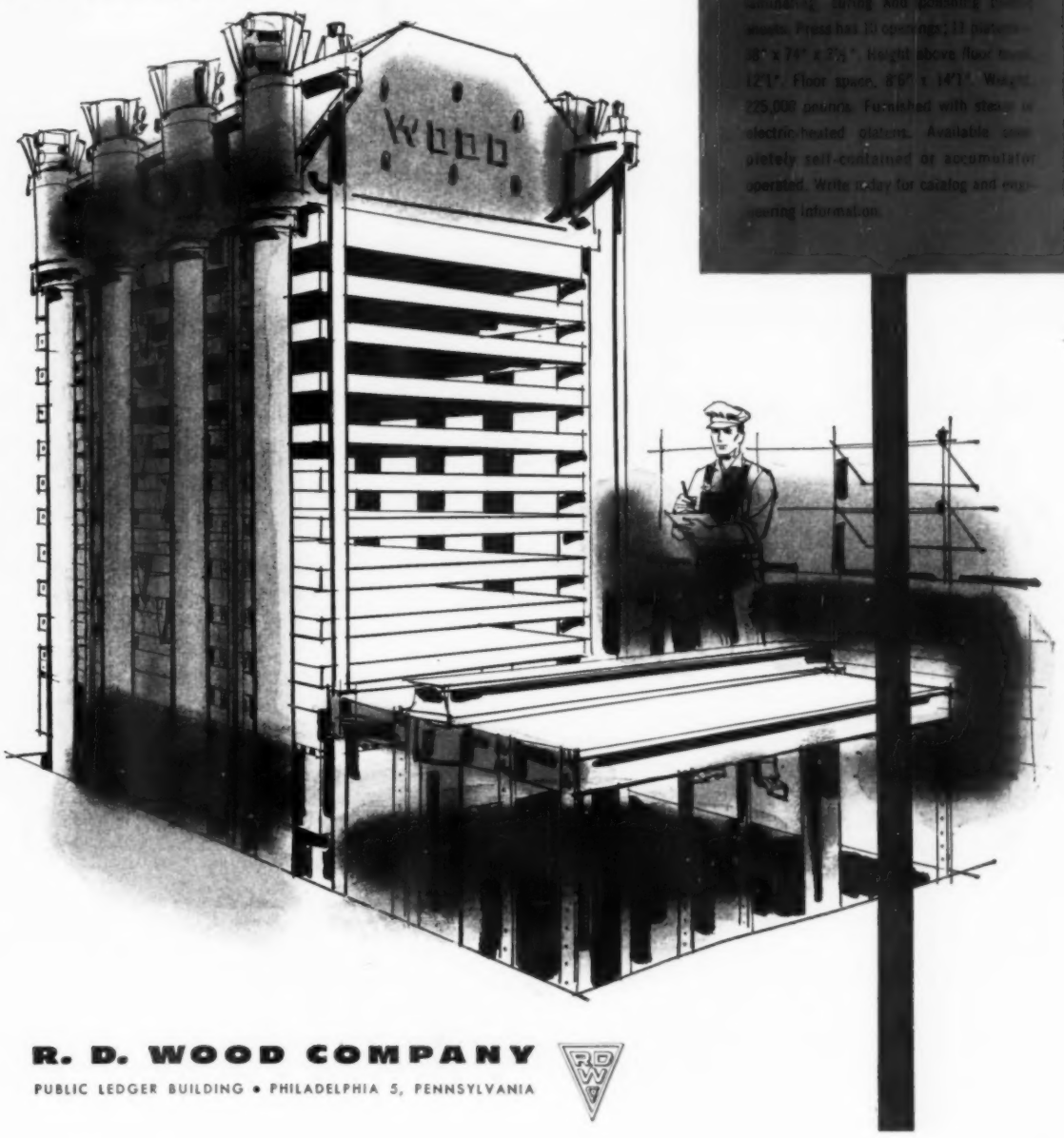

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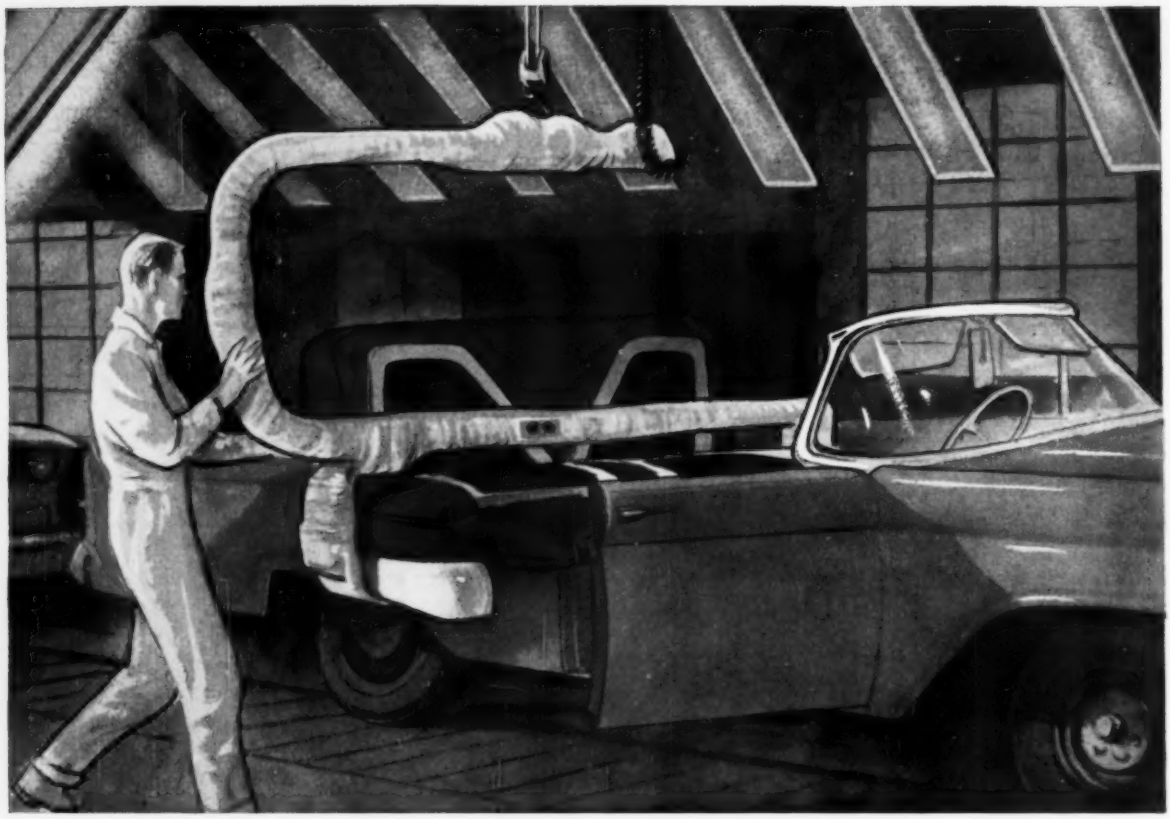

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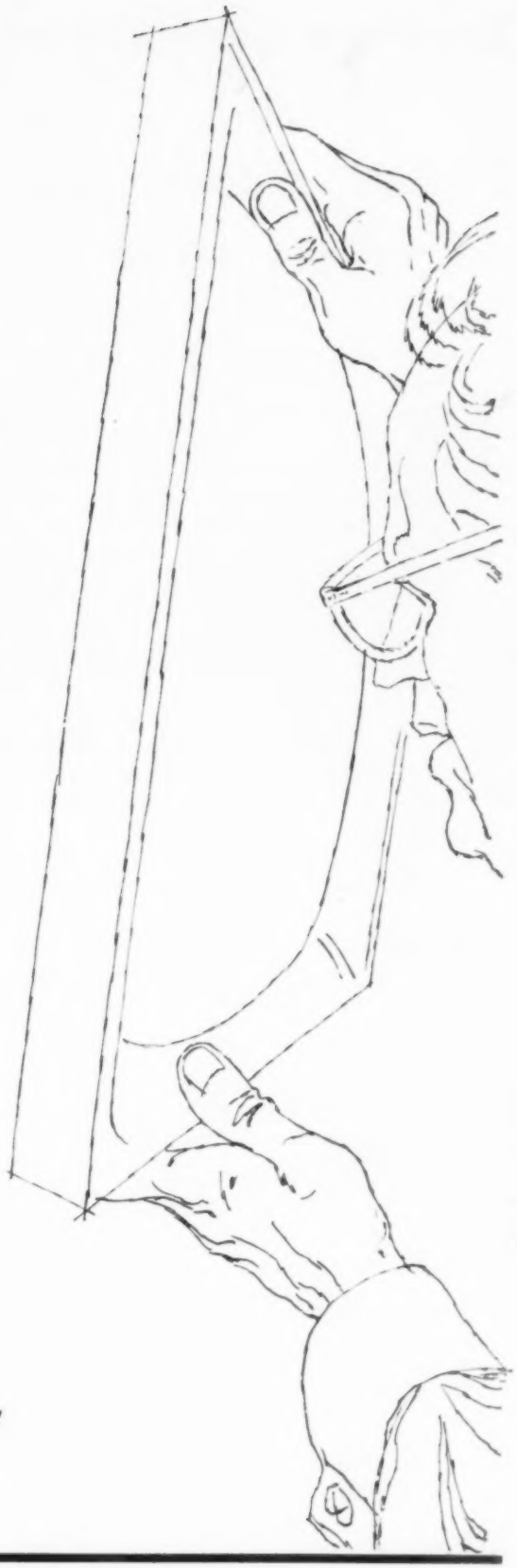

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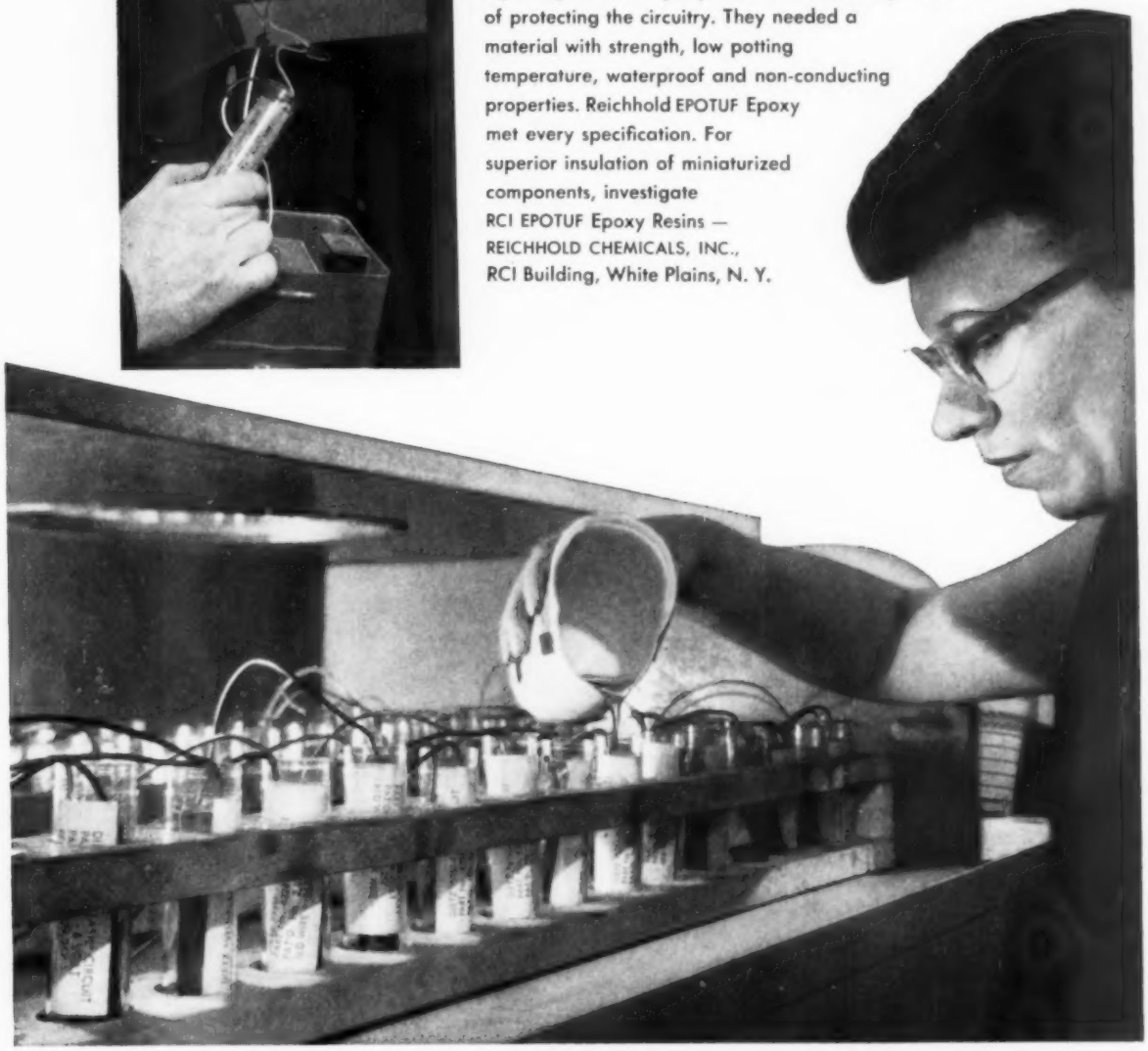

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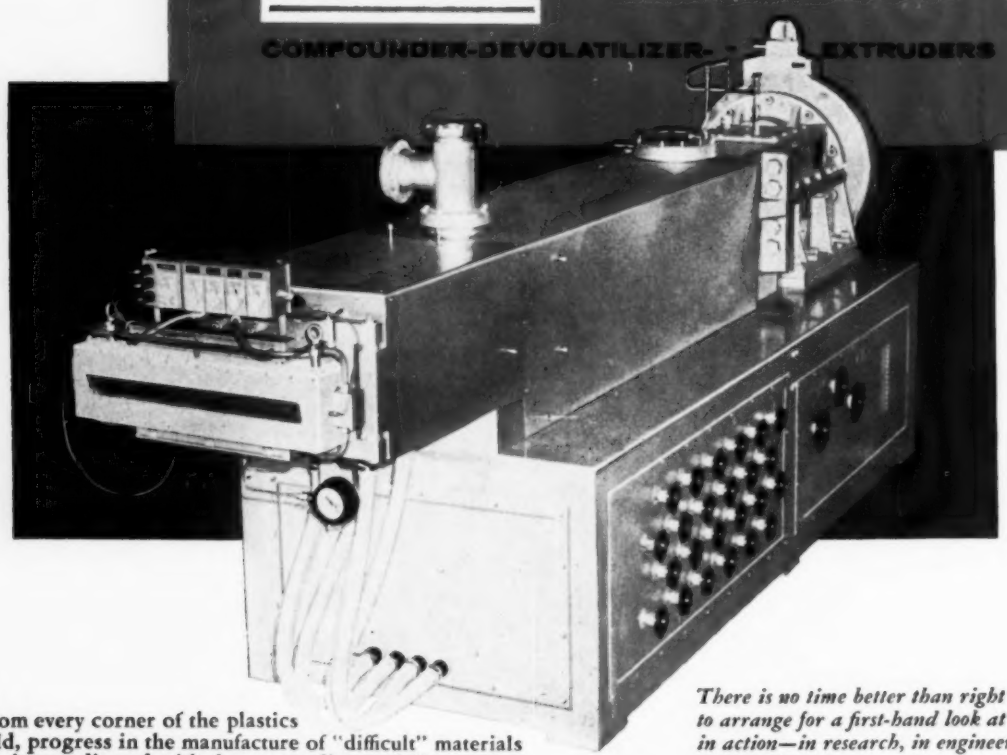

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PLASTICS
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TECHNOLOGY

Embrittlement of Polyethylenes

Tests show that embrittlement is a result of an increase in polymer crystallinity and polymer oxidative degradation.

C. S. IMIG, *Senior Staff Member,*
Sales Service Leboratory,
Spencer Chemical Co.,
Kansas City, Mo.

OVER the past year or so, higher-density polyethylenes have been available to molders and extruders in this country. It is believed that the introduction of these materials would greatly increase the consumption of polyethylene and markedly broaden end-use applications. A processor now can select almost any density polyethylene he wishes from 0.914-0.964 in order to obtain the optimum in processing characteristics and physical properties.

One of the most important property changes that is seen as polyethylene density is increased is greater resistance to heat, as shown by the higher heat distortion temperature or softening point. However, it has become apparent that there are other important considerations. Samples have exhibited brittle-failure after being subjected to temperatures near the boiling point of water. Based on heat distortion and softening point data, one would have predicted that the materials should have performed satisfactorily.

In addition to considering such factors as ease of flow, tensile strength, stiffness, and heat distortion, we also must look at heat embrittlement. The term, as used in this paper, refers to the phenomenon whereby an ethylene polymer loses its mechanical properties after conditioning at an elevated temperature below the crystalline melting point of the polymer. This loss

Charles S. Imig was born in Milwaukee, Wisc., in 1928. He attended Carroll College (Waukesha, Wisc.) and the University of Wisconsin, receiving a B.S. in Chemistry from the latter in 1950. After graduating, he was employed by Phillips Petroleum Co. from 1950-54 as a Research Chemist. He joined Spencer Chemical in Jan., 1955, in his present capacity as Senior Staff Member in the firm's Sales Service Laboratory. Mr. Imig is a member of ACS and SPE. Mr. & Mrs. Imig have one child, and make their home in Overland Park, Kansas.

of mechanical properties usually is such that the elongation is nil, and a test specimen will display a brittle fracture when folded back on itself.

Nature of Embrittlement

During the evaluation of a particular polyethylene sample, it was observed that the sample would display a brittle fracture when folded back on itself after exposure to elevated temperatures. In order to gain better insight into this phenomenon, melt index and density determinations were carried out during the embrittlement. Compression molded samples measuring 1.5 x 0.5 x 0.07-inches were conditioned in a circulating air oven at 220° F. The specimens were removed from time to time in order to check for embrittlement (by folding the specimen back on itself), for density, and for melt index.

After embrittlement (when the sample broke on the first fold), the samples were milled for about five minutes, and melt index and density again were determinted. The data are shown graphically in Figures 1 and 2. In Figure 1, we see that the density increased quite regularly with time until the sample became brittle after 136 hours. After milling and remolding, however, the density returned to approximately its original value. Going to Figure 2, we observe that the melt index also gradually increased with time until the sample became brittle. In contrast to the density, however, the melt index showed a marked increase after milling.

In looking over the above data, it is apparent that there are two factors involved in this heat embrittlement phenomenon. The first is a temporary physical change in the crystalline structure of the polymer as shown by the density increase, followed by a return to the original density after milling. The second is a permanent chemical change of polymer degradation from chain scission, as seen by the increase in melt index even after milling the embrittled samples. These two factors may or may not be independent of one another, and will be dealt with separately.

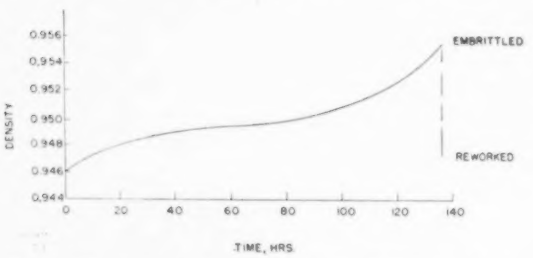

Fig. 1. Change in density of high-density (0.95) polyethylene with heat aging at 200° F.

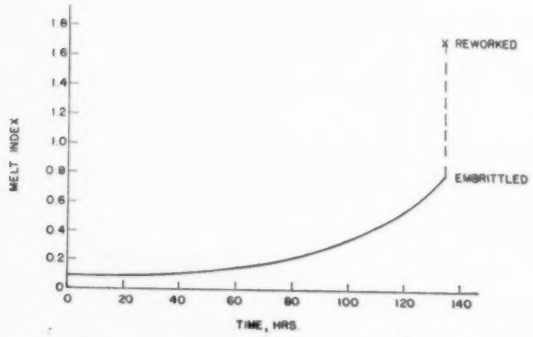

Fig. 2. Change in melt index of high-density (0.95) polyethylene with heat aging at 220° F.

Crystallite Growth

Conditioning a sample at a temperature below its crystalline melting point, or annealing, is nothing new to the plastics industry and, in fact, is used commonly to relieve molding strains. When polyethylene is annealed for 30 minutes in boiling water prior to testing, we expect an increase of about 0.002 gram per cubic centimeter in density, with a corresponding change in all other properties which are affected by crystallinity.

It is not unreasonable to expect that further conditioning at elevated temperatures could result in even greater increases in density or crystallinity up to some limiting point. Since it is recognized that an increase in density is accompanied by an increase in brittleness, we would expect the polymer to embrittle to some extent, depending on the time of exposure. This is in agreement with work reported earlier by Foster and Spahn (4)* on lower-density polyethylenes.

Using a polymer of lower crystallinity or density should reduce or eliminate this phase of the embrittlement. Practically, of course, this is not possible since many physical properties depend to a large extent upon crystallinity. Therefore, we would be defeating our original reason for selecting the material. The only alternative would be the incorporation of an additive which would not impair seriously the physical properties of the polymer, but which would interfere with crystallite growth. Such an additive might be butyl rubber, commonly known to be quite effective in improving environmental stress-cracking resistance.

Samples of a 0.935-density, melt index 1, polyethylene were compounded with 5% and 10% butyl rubber. These samples were injection molded into 2.25 x 0.5 x 0.07-inch test specimens on a two-ounce molding machine, along with a control sample not containing butyl rubber. The samples were conditioned, as before, in a circulating-air oven at 220° F., and checked periodically for embrittlement by folding the specimens back on themselves. The time for brittle-failure to occur on the first fold was recorded. In addition, densities were determined both before and after heat aging. The results are shown in Table 1. It is obvious that the addition of up to 10% butyl rubber did not improve the resistance to heat embrittlement. Also, judging from the marked increase in density of the three specimens, this additive did not inhibit crystallite growth as had been hoped.

Other additives to inhibit crystallite growth presently are being studied.

Oxidative Degradation

Along with density increase, we also saw polymer

* Numbers in parentheses refer to Bibliography at end of article.

degradation taking place through chain scission. The most obvious mechanism for this would be oxidation of polymer molecules to hydroperoxides, followed by chain scission. There has been a considerable amount of data published about the oxidation of polyethylene (1,2,5,7,8,9). Oxygen does attack polyethylene, and the attack is temperature-sensitive and autocatalytic, and may be inhibited successfully by using antioxidants.

To establish that oxidation actually takes place during this embrittlement phenomenon, samples of intermediate-density polyethylenes heat-aged for 88 hours at 230° F. were examined with an infra-red spectrometer. The data obtained is summarized in Table 2. It may be seen that the amount of branching (as indicated by the amount of methyl groups) and the amount of total unsaturation did not change significantly for any of the three materials tested. Similarly, there were no significant differences in the amounts of the various types of unsaturation. In each case, however, there was an increase in the amount of carbonyl present showing that the polymer had undergone oxidation.

Since oxidation occurs during the heat-embrittlement phenomenon (according to Kavafian (6), this is essential), it seems logical to assume that the addition of an anti-oxidant should improve the resistance of a polymer to heat embrittlement. It has been reported by Carey, Snyder, and Vakos (3) that antioxidants varied in their effectiveness in overcoming this heat embrittlement. They were reported effective at high strain levels (about 50%), but not at low strain levels (about 10%). Antioxidants are being studied for their effects on this heat-embrittlement phenomenon.

Polymer Structure

In addition to the above two factors that account for this embrittlement, which can occur singly or together, certain base polymer characteristics also can contribute to the embrittlement of the polymer. The two commonly-used means for identifying polyethylenes—melt index and density—then were investigated to determine their effects on resistance to heat embrittlement.

Compression-molded test specimens from three different density resins of similar melt indexes were conditioned at 200° F. and checked for embrittlement as before. These resins ranged in density from 0.935-0.963, and were prepared by using three different polymerization methods. Time to reach embrittlement ranged from 40 to more than 260 hours, but did not vary regularly with polymer density.

(Continued on page 68)

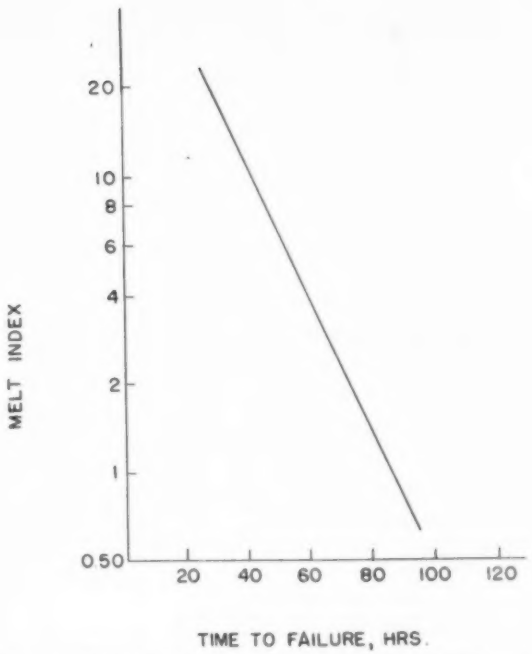

Fig. 3. Effect of melt index on resistance to heat embrittlement of intermediate-density (0.935) polyethylene at 230° F.

Table 1. Effect of Butyl Rubber On Heat Embrittlement Of An Intermediate-Density (0.935) Polyethylene.*

Amount of Butyl Rubber, %	Time to Failure at 220° F., Hrs.	Density	
		Original	Final
0	168	0.928	0.953
5	168	0.928	0.960
10	168	0.927	0.955

*Injection-molded test specimens

Table 2. Infra-Red Analysis of Intermediate-Density (0.935) Polyethylene Before And After Embrittlement.*

Melt Index (D1238-52T)	% Methyl		% Total Unsaturation		% Carbonyl	
	Before	After	Before	After	Before	After
0.8	1.2	1.0	0.026	0.028	0.02	0.08
4	0.9	1.1	0.035	0.029	0.02	0.07
20	1.2	1.2	0.020	0.027	0.02	0.04

*88 hours at 230° F.

Table 3. Effect of Molding Temperature On Heat Embrittlement Of 0.95-Density Polyethylene.

Temperatures, °F.			Cycle Time, Sec.	Pressure, Psi.	Time to Embrittle at 220° F., Hrs.
Cylinder	Stock	Mold			
450-500	465	80	90	1,500	96
550-675	595	80	90	1,000	168

Molding of Diallyl Phthalate Compounds

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Characteristics affecting the molding of filled compounds are described, together with molding defects and their elimination.

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DURING the past few years, a group of specialty thermosetting molding compounds based on diallyl phthalate resins have become available. These materials offer designers unusual combinations of properties, such as exceptionally high insulation resistance under high-humidity conditons, good dimensional stability, and good mechanical strength (1)**. Because of their desirable properties, these materials are widely used in the manufacture of electrical components for guided missiles and in other critical military applications (2).

Considerable data have been obtained on the molding characteristics of DAP materials which are not widely used in consumer applications. Some of this information and a few typical problems associated with the use of these materials will be discussed.

DAP Molding Compounds

Diallyl phthalate resin may be combined with various fillers to give a series of molding compounds having a wide range of properties. The fillers most commonly employed are asbestos fibers, glass fibers of various lengths, and synthetic organic fibers such as Orlon and Dacron. Finely-powdered, inert mineral fillers can be used in combination with all of these fibrous materials. Typical properties for some representative DAP molding compounds are given in Table 1. For purposes of brevity, the terminology appearing in the table will be used throughout.

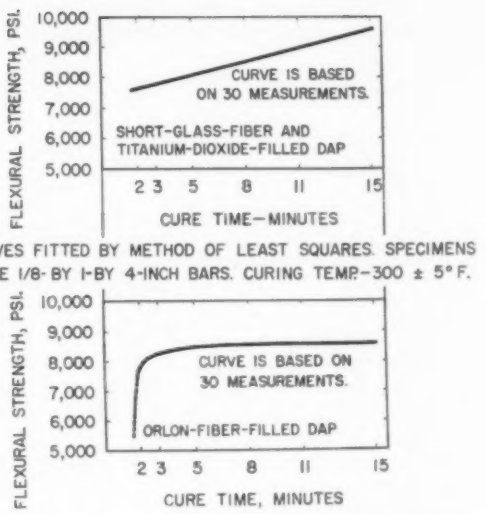
* Now Head of Non-Metallic Mat'ls Group, The Martin Co., Denver, Colo.
** Numbers in parentheses refer to Bibliography at end of article.

Molding Properties

As with other materials, the molding characteristics of DAP compounds vary according to the types and amounts of fillers incorporated in them. However, these compounds have certain characteristics which result largely from the resin only. The DAP materials, in general, exhibit a high molding shrinkage when compared with other commonly-used materials. Since polymerization is of the addition type and does not involve a condensation reaction, the materials give off practically no volatile matter during cure. Breathing or "bumping" of the molding during cure, therefore, is seldom necessary.

DAP molding materials may be formulated in many plasticities without the need for additives to control flow. The range of flow values obtainable, together with a fairly long fluid period during molding, have made it possible to use DAP materials in a wide variety of compression- and transfer-molded parts ranging from those with very small and intricate shapes to very large, thick parts involving deep draws.

DAP compounds appear stable during storage, provided that they are not exposed to high temperatures. No aging should be anticipated over a 12-month period for compounds stored at 40°-50° F. Temperatures in excess of 80°F. effect some increase in the stiffness of DAP molding materials. In mineral-filled DAP, an increase of 3-4 seconds in the molding index at 10 tons was observed over a six-month period for materials stored at room temperature (i.e., at temperatures usually in excess of 80° F., and exceeding 100° F. on several occasions).



CURVES FITTED BY METHOD OF LEAST SQUARES. SPECIMENS WERE 1/8- BY 1-BY 4-INCH BARS. CURING TEMP.—300 ± 5° F.

Fig. 1. Effect of cure time on flexural strengths of Orlon fiber-filled and glass-titanium dioxide-filled diallyl phthalates.

Completeness of Cure

The effect of mold cure time on the flexural strength of two DAP materials can be seen in Figure 1. Note that the Orlon-filled material showed little improvement in flexural strength after initial cure, but that the titanium dioxide-loaded material improved gradually in strength with increased cure. The rapid cure exhibited

Table 1. Properties of Commercially-Available DAP Molding Materials.*

Property	ASTM Test Method	DAP Molding Materials: Asbestos-filled	Short glass fiber-filled	Long glass fiber-filled	Dacron fiber-filled	Orlon fiber-filled	Short glass fiber-and TiO_2-filled
Tensile strength, Dogbone, Psi.	D651	5,500	7,500	7,000	4,600	4,500-6,000	5,500
Impact strength, ft.lbs./in. notch	D256	0.46	0.55-0.8	6.0-8.0	4.2-4.5	0.5	0.3
Dimensional stability	——	Excellent	Excellent	Excellent	Good	Good	Excellent
Molding shrinkage, In./in.	D955	0.006-0.007	0.002-0.004	0.002-0.004	0.009-0.010	0.009-0.010	0.004-0.005
Preforming characteristics	——	Can be performed in standard machines		Require high bulk factor-type of preforming equipment			Can be preformed in standard machines
Bulk factor of loose powder	D1182	2.2-2.3	1.9-2.0	4.0	5.2	5.2	0.8-2.1
Remarks	——	Std. electrical connector insert matl.	Low dielectric loss properties	Very good molding props. for long glass fiber-filled compounds	Good combination of impact strength and high insulation resistance. Good resistance to cracking during soldering of molded-in inserts		Intended for special radome applications
Terminology used in this article		Asbestos-DAP	Short glass-DAP	Long glass-DAP	Dacron-DAP	Orlon-DAP	Mineral-DAP

* All values taken from manufacturers' literature.

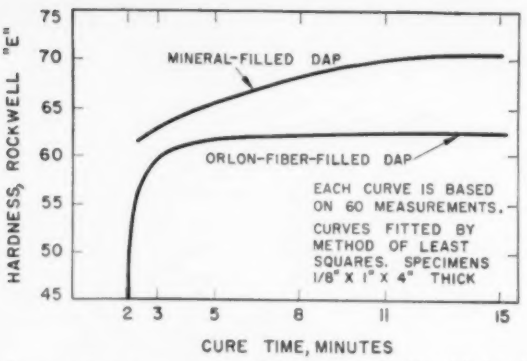


Fig. 2. Effect of cure time on hardness of Orlon fiber-filled and glass-titanium dioxide-filled diallyl phthalates.

by the Orlon-DAP is typical of a polyester resin material. Probably the TiO_2 filler, acted as an inhibitor and slowed the cure.

Most DAP compounds exhibit the curing behavior shown by Orlon-DAP. If sufficient cure is attained in the mold, post-curing will not improve dimensional stability or physical properties markedly.

A very similar set of curves was obtained for the same two materials when hardness was plotted versus cure time (see Figure 2). The sharp attainment of maximum hardness of the Orlon-DAP compound suggests hardness as a test for completeness of cure.

Another simple cure test for DAP parts, which requires refluxing in chloroform for three hours, was devised by the Los Alamos Scientific Laboratories, Los Alamos, N.M. Remnants of the Orlon-filled DAP parts from the flexure tests described above were subjected to this chloroform resistance test. For a given specimen thickness and mold temperature, both the hardness curve (Figure 2) and the chloroform test show that reasonably complete cure was attained in three minutes. This fact also is shown by the flexural strength curve in Figure 1.

Dimensional Stability

The effect of cure time on the dimensional stability of DAP materials also has been examined. A curve of cure time versus the volumetric growth resulting from exposing parts made of Orlon fiber-filled DAP to 100% relative humidity and 160° F., shows that increased cure time definitely increases the stability (i.e., reduces the growth of the part) after both short- and long-time humidity exposures, and also after three months exposure. These data indicate that the cure conditions to which a part is subjected during molding may have a rather permanent effect regardless of high-temperature and high-humidity conditioning. These specimens were anisotropic in their linear-growth properties in the length, width, and height directions. The percent growth was much greater in the height direction (direction of applied pressure) for DAP materials.

This anisotropy has been demonstrated in other materials, such as glass fiber-filled alkyds. Since this effect is much more noticeable in long fiber-filled materials, it is probably due to an orientation of fibers in the direction of flow, rather than in the direction of molding. This effect, which may be described as an unmolding or "memory," is encountered in varying degrees with both preform and loose powder moldings, and also is present to a minor degree in materials which do not contain fibrous fillers.

Dimensional stability after 10 months of storage at room temperature also has been investigated (see Table 2). The dimensional stability of DAP materials is excellent in comparision with that of phenolic materials. The slight difference in dimensional stability between the four- and 12-minute cured parts indicates that there probably is little residual chemical shrinkage in Orlon-DAP material, even at the shorter cure.

The effect of high-temperature aging according to MIL-P-14 (10 cycles of 48 hours each at 257° F., plus 24 hours at 78° F.) on the dimensions of parts molded under various conditions has been determined. Cure time and temperature had little effect on the dimensional stability, probably due to residual shrinkage—even at the shorter cure times. The asbestos-filled material had better dimensional stability than the Dacron- and Orlon-filled materials. It is not known how much of the diameter shrinkage, particularly of the synthetic fiber-filled material, actually was vertical because of volumetric change. Some "unmolding" or diametric shrinkage with vertical growth may have taken place, but this was not determined.

Flow

Experience in the compression molding of DAP compounds indicates that the ASTM "Molding Index" or "cup-closing" time provides a good measure of flow characteristics which can be correlated with actual molding conditions. In general, DAP molding compounds are available throughout a wide range of plasticities, from the extremely soft to the extremely stiff.

Table 2. Dimensional Changes in Specimens After 10-Month Storage at Room Temperature and Humidity.*

Material	Cure Time, Minutes	Mean Diametric Change Inches	Inches/Inch	No. of Specimens**
Orlon fiber-filled DAP	4	–0.0016	–0.0003	28
	12	–0.0004	–0.0001	137
Short glass fiber & TiO_2-filled DAP	8	–0.0009	–0.0002	14
Flock & fabric-filled phenolic	8	–0.0069	–0.0013	55

* Specimens were 5 3/16 by 3/8-inch discs.
**Two measurements of diameter were made on each specimen.

Table 3. Molding Index Values* for Filled-DAP Compounds

DAP Compound	Very Soft	Very Stiff
Mineral-filled	5	20
Orlon-filled	10	20
Dacron-filled	10	20
Short glass fiber-filled	3	8
Long glass fiber-filled	3	8

*Molding index at 300° F. in seconds at 20,000 pound clamping force.

Table 3 gives the approximate molding-index ranges for some DAP compounds.

The flow which may be required in any molding operation is determined by means of empirical measurements on the part mold itself. In most landed compression molds, stiffness of the material to be employed will depend on actual cavity shape and design of the flash restriction area. If the mold is fairly loose, considerably more flash will be obtained from a soft material than from a stiffer compound. Excess flash may result in a decrease in part size or density, and often can produce undesirable porosity. If the material used is too stiff, it is difficult to close or land the mold.

Figure 3 gives complete "molding-index" curves for mineral- and Dacron-filled materials. For most DAP compounds, the relationship of cup-closing time to clamping force in the 500-5,000 psi. range is approximately logarithmic.

As a quality-control measure, determination of the molding index has shown excellent results. In one precision-molding operation where flow measurements were introduced as a quality-control test, the rejection rate was reduced from 30-50% to 0-1%. To obtain adequate control, it seldom is necessary to measure the molding index at more than one clamping force and molding temperature. However, in determining what material flow will prove most satisfactory for a given molding operation, it is advantageous to have a knowledge of the entire molding-index curve. Figure 4 compares the flow curves of a soft and a stiff, short glass fiber-DAP with the corresponding long glass fiber compound. The rates of change in cup-closing time of the compounds having two different fiber lengths are different with respect to clamping force. Therefore, two materials having the same closing time at one tonnage may not exhibit the same values at other forces.

Transfer molding of DAP materials presents additional problems with regard to molding-index values. Total transfer time frequently is of major importance. Transfer properties of the material are better defined by cure rate than by a short-term material viscosity value obtained from the molding-index test. In such cases, it may be helpful to study the entire force-closing time curve in order to determine the approximate flow of compound at the time the transfer cycle is completed and full pressure is applied to the material. Materials which are suitably soft when tested at a given temperature and clamping force in the molding-index tester often will have a rapid rate of cure and will not completely fill large transfer molds.

In both transfer and compression molding, a careful study of the complete flow curves may prove the solution to molding problems. Adjustment of molding parameters, such as temperature, pressure, closing time, flash restriction, transfer-ram travel rate and pressure, and preheat conditions often will result in dense, flawfree parts—even from the most reluctant material.

Effect of Fiber Length

Mechanical properties of molded parts can vary with the thickness of molded sections in relation to the length of fibrous fillers. The effect of change in fiber length on the uniformity of molded properties may be

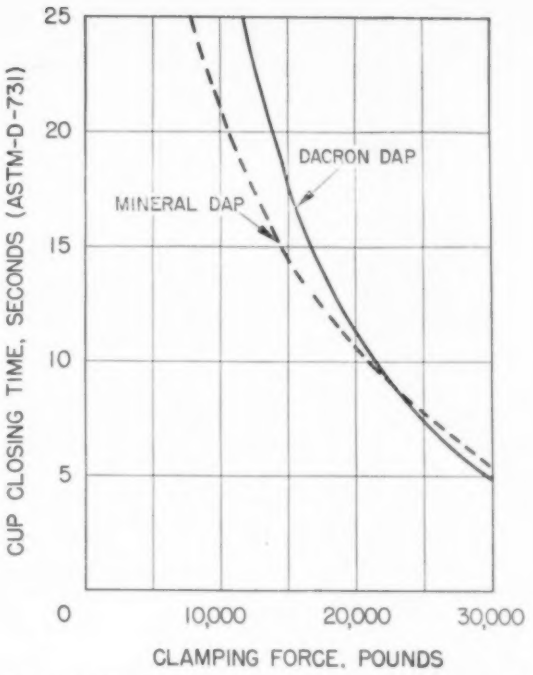


Fig. 3. Molding index curves for Dacron fiber-filled and mineral-filled DAP.

seen by comparing the coefficient of variation of flexural strength for an unmilled Orlon-filled DAP having ¼-inch-long fibers with that for the milled material having $\frac{1}{32}$-$\frac{1}{16}$-inch fibers (see Figure 5).

For a ¼-inch thickness, the longer-fibered DAP has a coefficient of variation of 15.7%, as compared with 4.6% for the shorter-fibered version. Apparently the longer fibers do not orient as uniformly during molding as do the shorter fibers.

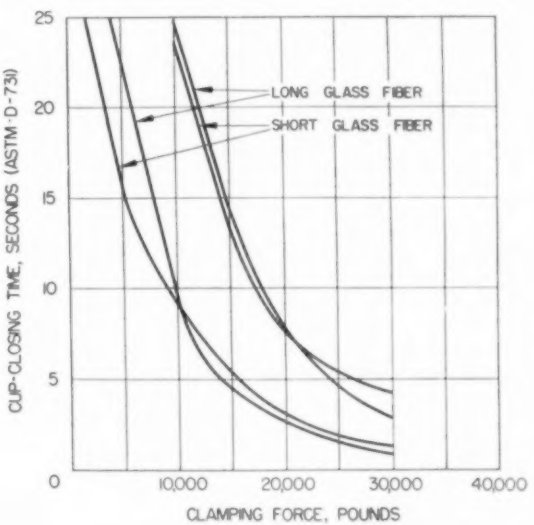


Fig. 4. Molding index curves for four batches of glass fiber-filled DAP.

Particle-Size Distribution

The distribution of particle size in mineral-filled DAP has a noticeable effect on the quality of moldings. An excessive amount of small particles in mineral-filled DAP makes the material difficult to mold into dense parts. Sieve analysis of two batches of the same formulation with similar flow characteristics showed that the material with the large proportion of fines consistently was molded into parts having severe internal porosity, despite all attempts to remedy the situation by varying molding conditions. Chemical analysis of the two batches revealed no significant differences.

The deleterious effect of a large proportion of small particles was subsequently confirmed in molding operations employing other batches. Also, if a batch with an acceptable amount of fines was sieved through a #50 U.S. Standard sieve, the material which passed through the sieve exhibited the same tendency to produce porous parts, while the portion retained yielded dense moldings. In order to obtain uniform moldings it was necessary to set up a specification for particle-size distribution for this particular material.

Molding Shrinkage

Molding shrinkages of DAP compounds (see Table 1) are high in comparison with those of phenolics having similar fillers, and also appear to be somewhat more dependent upon molding conditions.

Figure 6 shows the effect of cure time on the lateral molding shrinkage of two Orlon-filled DAP materials of different plasticities. For both batches, the molding shrinkage is greater at shorter cure times. This effect has been explained (3) as a continuation of cure and chemical shrinkage after the parts have been removed from the mold at short cure times.

In this Figure, the softer material (12 seconds at 10 tons) should be less highly advanced chemically and, therefore, it would be expected to have greater chemical shrinkage remaining at the time of molding. Also, the softer material would be expected to flash past the punch to a greater extent because of its lower viscosity or longer flow period, thus leaving less material to remain in the cavity. The mold used was a landed or fixed-cavity mold in which increases in molded-part weight should be reflected in decreases in molding shrinkage (3, 4). For a 170-gram charge weight, the average final part weight of the 20-flow parts was 166.75 grams, and that of the 12-flow parts was 164.85 grams. Since the 20-flow parts had more material in the cavity after molding and less chemical shrinkage during molding, they were subject to greater pressure and decompressed more when they were removed from the mold. This resulted in less molding shrinkage.

Parts molded from material of both plasticities which had been dried for two hours at 160° F. had somewhat lower molding shrinkages than those obtained on the non-dried material. This may be explained, as above, by the fact that the materials were advanced slightly by the predrying treatment.

Other Molding Properties

As with other thermosetting materials, shorter cure times can be obtained with higher molding temperatures (280-320° F.). With some DAP compounds, superior surface appearance is obtained at the higher temperatures.

Preheating in an oven or by a dielectric preheater often is useful in molding DAP materials. The dielectric method is favored, and the materials preheat readily when preformed. Normally, DAP materials are not preheated to the smoking point as phenolics sometimes are. DAPs are preheated only until soft to the touch, since the purpose of preheating usually is to warm these materials, not to drive off water or other volatiles. Too great a preheat reduces flow time in the mold and can prevent proper filling out of mold cavities.

Oven preheating may be indicated if the material is in powder form, or if it has absorbed volatiles during storage. A typical oven preheating cycle is 15 minutes in a hot-air circulating oven at 140-160° F.

Predrying rarely is necessary with DAP materials unless they have an abnormally high volatile content (greater than 1% by weight) or it is desirable to advance the materials and, thereby, stiffen the flow. In such cases, predrying temperatures as high as 200° F. may be employed for periods as long as two hours.

Preforming often is desirable to aid in proper fiber

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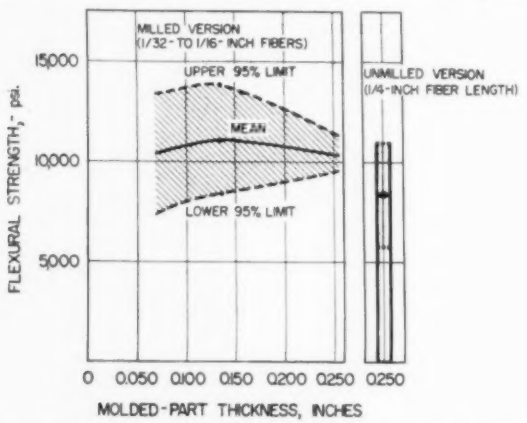


Fig. 5. Effect of molded-part thickness on flexural strength values for milled and unmilled Orlon fiber-filled DAP.

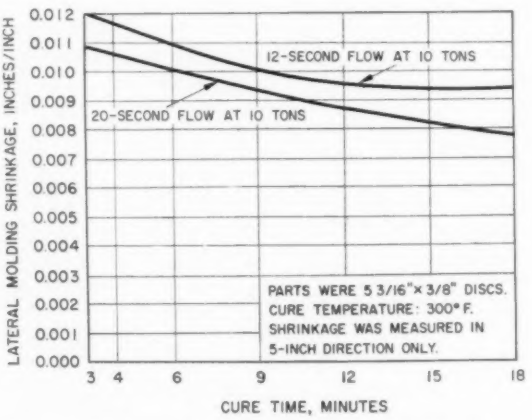


Fig. 6. Effect of cure time on molding shrinkage of Orlon fiber-filled DAP.

What a Plastics Engineer Should Look for When Planning to Buy Auxiliary Equipment for Injection Molding

The utility, cost range, and applications for 12 principal items of auxiliary equipment are described and discussed.

G. B. THAYER, *Plastics Specialist, Plastics Technical Service, Dow Chemical Co., Midland, Mich.*

BUYING an injection molding machine is something like buying an automobile. Each buyer needs some different combination of accessories. The capital investment for molding plant extras can be 10-50% of the basic machine cost. Manufacturers of molding machinery* cannot possibly anticipate all of the combinations which their customers will want or need and, for this reason, none of the machine tool builders offer a full line of auxiliary equipment.

A molding plant could not run at all today if it did not have the auxiliary equipment that has been developed during the past 10 years. Molding machines themselves have increased in complexity and cost during this time, and it is very important to provide all needed extra equipment to allow a machine to produce the maximum amount of fabricated products. In addition to supplementing the production ability of the injection molding machine, the auxiliary equipment may be necessary to produce satisfactory quality in molded articles.

Cost Ranges

A tabulation of the cost range of 12 principal items of auxiliary equipment which are discussed here is shown in Table 1. The numbers have been rounded off and, in most cases, the cost range from lowest to highest is quite large. This is because a wide variety of equipment in each category is available and, in general, the cost reflects the value of the equipment rather accurately. Some of the simpler pieces are relatively low in cost, while the more complex ones are much higher.

It is not possible to prepare an accurate cost estimate for the equipment to supplement a molding machine from this Table because prices must be based on spe-

*See "What a Plastics Engineer Should Look For When Planning to Buy an Injection Molding Machine," by G. B. Thayer, PLASTICS TECHNOLOGY, 4, 5, 439 (May 1958).

Table 1. Cost Range of Auxiliary Equipment for Injection Molding

Hopper Loader	$150-400
Hopper Dryer	400-1,000
Drying Oven	150-1,000
Weigh Feeder	400-1,500
Voltage Regulators	50-800
Proportioning Heater Control	200-600
Extra Heating Cylinder	3,500-5,500
Nozzle Valve	400-1,800
Nozzle Pressure Regulator	400-600
Multiple Nozzles	800-2,500
Mold Temperature Regulator	300-1,800
Scrap Grinder	200-1,200

cific quotations at the time of making the estimate. Auxiliary equipment should be combined for maximum versatility within the needs of the plant and the capital available. It is not wise to select the most expensive equipment in the belief that it will be the best for the plant. It is better to select the proper equipment in the combination required, without regard to price.

Considerations for Auxiliaries

There are several manufacturers of each of the types of equipment discussed here. Each manufacturer offers a range of models to suit the various needs in the molding plant. It is often difficult for the plant engineer to differentiate between manufacturers on the basis of quality, service, integrity, and the other moral attributes of vendors. The difficulty probably arises because they are all trying to do well by their customers, and there is very little difference between them in this regard.

The functions of the auxiliary equipment are important, and the engineer should consider what the equipment must do. Therefore, he should base his specifications primarily on these factors. The discussion which follows is based on the functions which auxiliary equipment should perform to help the injection molding machine accomplish its work.

Hopper Loaders

Hopper loaders are used to convey plastic granules from a shipping container to the hopper above the molding machine. The capacity of most available loaders is such that they can supply 300-400 pounds of granules per hour. This is enough for nearly all molding machines in use today.

Some hopper loaders are powered by compressed air. The air passes through a venturi which creates a low-pressure area behind it and draws granules from the container on the floor up to the venturi. From this point, air pushes the granules through a delivery tube upward to the hopper. The simpler type of air conveyors do not preheat the granules, but merely convey them from the container to the hopper. Some types of hopper loaders employ dried and heated air to force the granules from container to hopper. Probably, the fact that the air is dry is more importan than that the air be warm. The preheating which can occur during the passage of granules through the pipe is negligible. Some hopper loaders also combine heaters which can add appreciable heat to the granules before they are conveyed to the hopper. Other types of conveying systems operate by a sort of vacuum-cleaner action.

The hopper loader is one of the major labor-saving devices in the injection molding plant. Before hopper loaders were in general use, the molding plant was considerably more dangerous than it is today. Someone had to climb a ladder with a pail of granules to pour them in the hopper. This was a very tiresome task, as well as a dangerous one. The hopper loader can save a great deal of plastic granules when its operation is compared to hand-filling the hopper by means of pails. Spilling a few ounces of granules every time the hopper is filled can result in considerable cost over a period of one month in the molding plant. Hopper loaders may be used with the suction pipe inserted through a very small hole in the cover of the container. This can help greatly in preventing contamination of the granules.

Venturi-type hopper loaders are probably the most commonly used because they are relatively simple and do merely one thing—move the granules from the shipping container to the hopper. It is important to have the air clean and dry when such loaders are used.

Hopper Dryers

Hopper dryers perform two functions for injection molding; they remove moisture, and preheat the granules to soften them. Hopper dryers force heated air into the hopper, and this air is distributed by a cone and screens to heat the plastic evenly. Injection mold-

Table 2. Preheating and Drying Considerations for Injection Molding

Molding Material	Absorb Moisture	Small Trace Of Moisture Interferes With Molding Quality	Preheat Temperatures, °F. Max. Air Temp.	Ideal Granule Center Temp.	Caking Temp.
Nylons	Yes	Yes	275	200	250
Polystyrenes	No	No	260	160	185
Cellulosics	Yes	Yes	220	150	175
Polyvinyl chloride	No	No	250	150	180
A-B-S Polymers	No	No	275	160	180
Acrylonitrile-styrene	Yes	Yes	275	180	200
Methacrylate	Yes	Yes	280	170	190
Polyethylene	No	No	275	150	195

ing materials which do not absorb moisture may be dried easily, and hopper dryers can remove the surface moisture adequately in most cases. Materials which absorb moisture are very difficult to dry, and hopper dryers may not always have sufficient capacity to dry them. Sometimes an extremely large hopper which allows the plastic to be subjected to drying for two hours or more before it is used, helps to accomplish drying. Materials which do not absorb moisture are usually not difficult to mold when only traces of moisture are present. The materials which absorb moisture, however, usually have to be extremely dry to avoid blisters and laminations.

Preheating and drying considerations for injection molding are shown in Table 2. The temperatures in the Table are approximately correct for ordinary conditions. The maximum air temperature shown may cause caking on prolonged holding in the hopper with the dryer blowing hot air, but the granules should not be expected to cake if a continual flow of granules through the hopper is maintained. The ideal center temperatures for the granule are not likely to be achieved with ordinary-size hoppers and average molding cycles. Both preheating and drying require the granule to be heated all the way through, even though the outside of the granule may be considerably hotter than the center. If the air supply is too hot, caking will occur without softening or drying the center part of the granule.

Preheating is an effective aid to molding when it softens hard granules (such as polystyrene, methyl methacrylate, and ABS polymers) thoroughly. This allows the granules to crush together and squeeze air out before it becomes trapped between the granules. If the granules are heated to a sticky surface on the outside and are still hard inside, it is relatively easy to trap air and force it through the heating cylinder on into the mold where it is a major cause of surface blisters.

Drying Ovens

Drying ovens often are needed to dry cellulosic materials and nylons because these materials must have extremely low moisture content in order to be molded satisfactorily. Hopper dryers usually cannot be depended on to dry these materials thoroughly in all cases. In humid weather, or when granules have been stored for a long time, a hopper dryer may not be able to eliminate enough moisture and it will be necessary to use a drying oven.

Many kinds of ovens are available, heated by steam or electricity. Electric ovens probably are the most convenient for injection molding plants which ordinarily do not have steam for heating. Air is blown over the heaters to warm it, and the oven is baffled to make the air flow over the granules which are placed in trays in the oven space. Usually, the trays also serve as baffles.

The ovens should be large enough to hold at least two hours supply of material when the granules are placed ¾-1 inch deep in the tray. The caking temperatures and air temperatures shown in Table 2 are satisfactory also for oven drying.

Oven drying is not a very efficient preheating means because the granules cool very rapidly after being taken out of the oven and placed in the machine hopper. If preheating is desired, the drying oven will warm the granules thoroughly, and then they can be kept warm by the use of a hopper dryer. The air should be filtered and reasonably clean, and should be controlled carefully in the summer when the amount of moisture in the air is high. On an extremely humid day, the drying oven actually may add moisture to the granules, rather than remove it.

Weigh Feeders

Weigh feeders are used extensively for weighing the charge of plastic granules into the molding machine. This is a much more accurate means of measuring the quantity of granules than the volumetric method.

If a weigh feeder of great precision is used, it must be given the opportunity to perform or its cost will be wasted. One of the chief problems that occurs in weigh feeding is improper attention to the uniformity of the molding cycle and to the temperature of the plastic in the melted zone. The accuracy of weight of the finished molded part depends on uniform resistance to plastic flow in the heating cylinder, as much as it does on accurate weighing of the charge. Varying cycles can change the temperature of the melted plastic and, therefore, its resistance to flow. This has the effect of changing the combined length of the plunger and the cold granule column directly in front of the plunger. Variation in voltage on the heater bands at various times of the day, and non-uniformity of cycles often are the real causes for unsatisfactory performance of weigh feeders. When the weigh feeder appears not to be performing properly, the operator is tempted to make adjustments too frequently and to make the adjustments too large. This affects the accuracy of the weighing and throws the entire operation out of balance.

Weigh feeders will not be dominant in controlling the weight of material in the mold when a nozzle valve and timer system are used. The nozzle valve controls the amount of material placed in the mold. If a weigh feeder is used in conjunction with a nozzle valve, the weigh feeder need not be the most precise and accurate unit available.

Some weigh feeders have self-compensating devices which tend to even-out the amount of material charged to the cylinder. If the cylinder becomes partly empty because of an extra-large shot being placed in the mold, the compensator adds material to make up for the loss. Conversely, if the heating cylinder becomes too full of granules, the compensator decreases the amount of feed. This type of device is useful when nozzle valves are not used and when cycles are subject to variation due to operator difficulties.

Weigh feeding ordinarily is not very useful for pre-plasticizing machines. The effect of weighing the charge into the heating cylinder of a pre-plasticizing machine is lost to a considerable extent when the molten plastic is placed in the injection cylinder. The injection cylinder should be built with stops to measure the charge accurately, thus eliminating the weigh feeder.

Voltage Regulators

Voltage regulators sometimes are used to control the

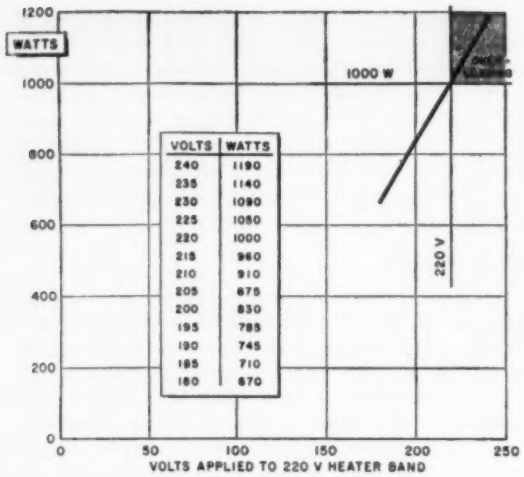


Fig. 1. Effect of voltage variation on heater band out-put.

voltage applied to the heater bands of the heating cylinder. Some voltage regulators are manually operated, and these are useful to control nozzle heater bands. Automatic voltage regulators have been on completely-automatic cycles to keep constant voltage applied to the heater bands when line voltage variations occur. This has been effective in avoiding short shots and flashing on automatically-operated machines.

When the line voltage decreases, the heater bands lose their ability to apply heat rapidly, as shown by the graph, Figure 1. A decrease in voltage of the main supply line can result in the plastic in the molten zone becoming much more stiff, and this upsets the feed to the machine as well as the injection speed which controls the quality of the molded part.

Variation in line voltage also changes the starting and running torque values of electric motors. A 10% decrease in voltage results in a 19% decrease in motor torque. When the motor torque decreases, the power that is available to drive the injection plunger forward also is decreased. This has a deleterious effect on the operation of the molding machine. Automatic voltage regulators are available up to 100-KVA and higher ratings in 440-volt, three-phase models. A 20-KVA unit costs from $1,500-1,900, and is sufficient in size to supply approximately a 25-horsepower motor. As far as it is known, voltage regulators are not used to control the line voltage applied to molding machine motors. It may be less expensive to install a larger motor which is less subject to overload during the injection cycle.

Proportioning Heater Controls

Proportioning heater controls offer the maximum precision in control of the heating cylinder temperature. They are especially good for automatic operations which must be kept under close control. On manual or semi-automatic cycles, the proportioning type of heater control may be of greater precision than the operation warrants. If the cycle is not kept uniform the proportioning controls keep the clyinder temperature uniform. This does not always assure uniform plastic temperatue, however.

Several types ot control circuits are used according to the preferences of the equipment manufacturers. Most of them employ a temperature-sensitive resistance element, rather than a bi-metallic thermocouple. The temperature of the heater body is measured by the change in resistance of the temperature-sensing element. The time of current "on" or "off," or the voltage applied to the heater band, is controlled in proportion to the resistance of the sensing element—hence the name "proportioning heater control." This type of heater controller can overcome line-voltage variations of 10% or more, and voltage regulators for the heater bands may not be necessary if the proper type of proportioning controller is used.

Extra Heating Cylinders

Extra heating cylinders often are purchased in a molding plant for several reasons. Sometimes special materials (such as nylon, polyvinyl chloride, and saran) require special designs since the cylinder should not handle other plastics because of difficult purging or possibility of contamination. It is advisable to have a spare heating cylinder in case of damage to the one in use. It may require several days to several weeks to repair a damaged heating cylinder or obtain a new one. Heating cylinders need to be disassembled and cleaned occasionally because purging cannot always completely remove all of the mixed colors from the cylinder. It usually is difficult to disassemble a heating cylinder in the molding plant because satisfactory equipment is not readily available. It probably is more economical to return the heating cylinder to the manufacturer for cleaning and refitting and, in such cases, it is necessary to have a spare heater.

Sometimes extra heating cylinders may be purchased for the purpose of up-grading the size of shot possible with the given molding machine or to increase the heating rate in pounds per hour. In such cases, the heating cylinder design may be special and considerably different from the standard design furnished by the manufacturer.

One of the primary considerations in selecting extra heating cylinders is not to reduce the available injection pressure by using an oversize plunger. It is not wise to increase hydraulic pressure to overcome the disadvantage resulting from the use of an oversize plunger. An oversize plunger operates satisfactorily in some cases, but it does not operate as well as the size originally designed to suit the machine. The manufacturer of the original equipment designs it to be universal in its ability to handle a wide range of moldability demand from the molds which the machine will encounter in the average custom molding plant.

Sometimes, too, it is difficult to obtain reliable information concerning the quality of special injection-molding heating cylinders. Reliable information is not actually available from many of the users because they do not keep written records. Sporadic observations by the manufacturer of the heating cylinder or by various material suppliers' representatives can be unreliable because of the complicating factors which may be involved. On one occasion, a poor mold may cause the heating cylinder to look bad; conversely,

in another plant, a mold of very low moldability demand may make the heating cylinder look exceptionally good. Still another example, a wall-tile manufacturer may find that a special heating cylinder will not produce a very satisfactory marbleized pattern, whereas the dry blend-colored waste baskets made by another manufacturer with the same heater design may turn out very well.

Nozzle Valves

The function of a nozzle valve is to open or close the nozzle at the will of the molding machine operator. When a nozzle valve is used in such a fashion as to allow the injection plunger to pre-compress the molding granules, it has the effect of up-grading considerably the injection power of the molding machine. In this operation, the valve is in the closed position as the injection plunger moves forward to the end of its stroke, or as far as it can go with the pressure available. Then, the nozzle valve opens and allows the plastic to escape from the heating cylinder under the pre-compression load on the granules plus the continuing force of the plunger which can move forward freely again after the valve has opened.

Nozzle valves are rather complex, have small parts, and operate under high load. This tends to subject them to damage easily. Set-up men and press operators should be instructed in proper handling procedure.

Nozzle Pressure Regulators

Nozzle-pressure regulation controls act by means of a pressure signal taken at the nozzle. Some regulators measure the expansion of the nozzle as the pressure causes the diameter to change. When pressure in the nozzle reaches a pre-set maximum, a relief valve in the hydraulic system opens to reduce the hydraulic pressure until it will hold plastic in the mold, but cannot force in more.

Calibration of nozzle pressure regulators need not be in units of pressure. The adjustment may be controlled manually from "maximum hydraulic pressure" to "holding pressure" when the mold is filled satisfactorily according to the judgment of the operator. It is not necessary to know the pressure at which this occurs, and it will occur at different pressures for different molds and molding conditions.

This system has been used successfully in controlling the injection molding process. It has not been used widely, as yet, because of several factors which include its newness and the problem of keeping the unit operating reliably. Many of the precision controls for the injection molding process will not stand very much abuse, and experienced plant operators have learned to avoid delicate instruments which are costly and may be subject to abuse.

This type of control can supplement the weigh feeder in excellent fashion, and it will help the machine produce good parts when the weigh feeder cannot control the amount of material placed in the mold. For example, when the machine is allowed to stop for as little as five seconds on a total cycle of 20 seconds, the plastic in the nozzle of the heater becomes more thoroughly heated and, hence, more fluid. The next stroke of the injection plunger very likely will put more material into the mold than should go in, even though the weigh feeder did not weigh in any more charge. If a nozzle pressure regulator is present, it will pick up the pressure signal as soon as the mold is filled properly and will reduce the injection pressure to a point where the plunger cannot force more material into the mold.

Multiple Nozzles

Although the use of multiple nozzles is not new, there has been a recent emphasis on the application of various types of multiple nozzles for automatic molding and high-production operations. Multiple nozzles deliver the hot plastic at various locations on the press platen. This is an advantage in eliminating the pressure loss which occurs when the plastic travels through a cold-runner system. Also, multiple nozzles reduce the amount of runner scrap and may result in a material saving of 10% or more.

Some nozzles are fed directly by branch passages attached to the heating cylinder and each nozzle has a hole in the press platen for itself. Others are arranged on a hot manifold plate on the inside of the front platen, and only one hole through the platen is needed to feed it. This actually is a modification of a hot-runner mold where the hot runner with its nozzles may be used for several different molds, and it is not necessary to build the hot runner into each mold.

Multiple nozzles may feed individual cavities or multiple cavities. Multiple nozzles sometimes are used to feed the same cavity in several places, but this must be done carefully to avoid air entrapment and flow marks. Such arrangements usually are made specially for a given mold, and are not applied universally to other molds. Valves in the individual nozzles may be used for sequential filling of the various segments of the mold through one nozzle at a time. Multiple nozzles, at other times are used to feed clusters of multiple-cavity molds. For example, a 64-cavity mold could be set up as four separate 16-cavity molds, each fed by an individual nozzle. Each nozzle, therefore, would feed a 16-cavity unit mold. It is possible to extend the efficiency of this type of molding further by having a fifth 16-cavity unit which can be in the shop for reconditioning while the other four units are producing. As soon as the spare unit is ready, it can be installed and another mold can be taken out of service to be reconditioned without interrupting the production from the injection press.

Mold Temperature Regulators

Mold temperature regulators should add heat and thus increase the temperature of the mold. They should also be able to remove heat at the mold temperature required for satisfactory molding quality. They should provide a sufficient volume of heat-exchange fluid under enough pressure to maintain good flow. Some mold temperature regulators are built to supply heat, but cannot cool readily. Others are built for cooling only, and cannot supply sufficient heat as required. The wide range in costs of these pieces of equipment is accounted for by the different design types.

The simplest type of mold-temperature regulators mixes hot and cold water to provide it at the proper temperature for the mold. This water usually is circulated once through the mold, and is either thrown away or recovered in a sump. Other types of mold-temperature regulators pump the heat-exchange fluid from a tank. This tank is supplied with a heater of the immersion type, while cooling is provided by valves which admit cold water to displace some of the water from the tank to the sewer.

Water economy and water quality are two factors which must be considered in the purchase of a mold-temperature regulator. If water is very expensive, it is advisable to consider the amount of water which the regulator uses. Some are extremely economical because of their method of controlling the water temperature, while others may "hunt" or vary from too hot to too cold. This requires extra electric heating power, as well as extra cooling water.

The quality of water is very important. It is essential that the water should not corrode or otherwise plug the passages in the mold or in the mold-temperature regulator. If the water must be treated chemically for use, it is advisable to have either a regulator that uses a minimum amount of water or have a large sump where the treated water can be returned and filtered.

Some mold-temperature regulators provide refrigerated water to keep the mold chilled to a temperature just above the dew point. The mold sometimes may be chilled below the dew point by refrigerated water and it still will operate satisfactorily as long as molding continues. This is true, since the heat from the plastic prevents the mold from chilling sufficiently to cause condensation of water from the air. Refrigerated water sometimes is useful in chilling a mold for fast cycles. At other times, however, it is better to provide water lines of more adequate nature within the mold. A large quantity of cooling water may remove the heat without having to undergo much change in temperature in so doing. If it is not possible to provide enough cooling-water passages in the mold, it may be necessary to use refrigerated water to maintain fast cycles.

The condition of the mold is extremely important because of its effect on the performance of the mold-temperature regulator. A mold which has inadequate drilling for passage of the heat-exchange fluid will not operate very well no matter how good or how expensive a mold temperature regulator is connected to it. Mold-temperature control has a dominant effect on the quality of the molded part, as well as the economy of the plant operation. If the mold is inadequately built, the mold-temperature regulator should not be blamed for poor performance.

Scrap Grinders

Grinders of all sizes are available to reduce molded scrap to useable granules. Scrap can be ground at the molding machine, at a central grinding location, or facilities can be provided to do both. Large injection-molding plants probably need a central grinding room, plus facilities for grinding at the machine. A very small plant with one or two machines may find it more economical to grind the scrap in one central place. This allows the dust and flying granules to be controlled, and allows the grinding to be done with fewer pieces of equipment.

If extra-large parts are to be ground, it may be advisable to saw the parts into smaller pieces to use a more economical-size grinder unless there is enough work for a very large one. Remember, a large grinder cannot be portable. It has to be fixed on substantial foundations and provided with many safeguards which are not necessary for small, portable grinders.

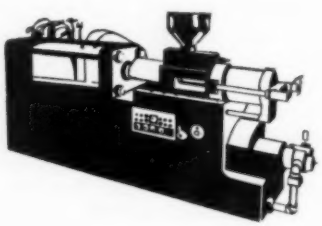
It is difficult to grind parts that have metal inserts because these inserts must be removed before the plastic can go into the grinder. The inserts usually do not damage the grinder extensively, but they are very bad when they go through the molding machine.

Conclusions

A dozen of the most important auxiliary equipment items have been discussed for the purpose of showing major considerations which must be taken into account when planning to buy the equipment. It is most important to decide first what the equipment should do in the individual plant. The functions expected of the equipment will vary from plant to plant according to the kind of work which is being done, and there is no way to make a satisfactory selection by choosing brand names or by inquiring of neighbors as to what they are using. It is satisfactory to select well-known equipment which is functioning properly for other people, provided the engineer has based his selection upon the true requirements of his own plant.

Auxiliary equipment is expensive, and it is the engineer's task to provide the proper functions at the lowest capital cost. He must be careful to avoid buying more functions than are needed, and he must be careful to provide the necessary functions. The burden placed on auxiliary equipment by purchasing functions which are not needed may be so high as to cause the equipment to suffer a bad reputation. Equipment which has built-in ability to perform work that it is not required to do, cannot earn its way readily. This is emphasized because auxiliary equipment should be amortized in a shorter time than a molding machine. The molding machine is a relatively permanent fixture, firmly set on a good foundation. Auxiliary equipment usually is portable and subject to considerably more abuse than the molding machine itself. As such, the auxiliary equipment is likely to wear out more rapidly.

—THE END



PT's Comparative Data on 1959 Injection Molding Machines

Company name*	Crown	De Mattia			Fellows				Harvey	
Machine model	Twinmaster AT	03	K2	K1	3-125	6-200	6-16-225	12-350	Formaton 2A	Formaton 3A
Machine action	Auto.	Semi-auto.	Auto.	Semi-auto.	Auto.	Auto.	Auto.	Semi-auto.	Auto.	Auto.
Machine type	Horiz.	Vert.	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.	Vert.	Vert.
Clamping mechanism	Hydr.	Hydr.	Hydr.	Hydr.	Toggle	Toggle	Toggle	Toggle	Hydr.	Hydr.
Injection capacity, oz./shot	1-3/ram	4	4-6	12-16	3	6	6-10	12-20	2	2
Casting area, sq. in.**	Approx. 50	Approx. 45	Approx. 90	Approx. 135	30	70	- -	115	25	37
Injection plunger stroke, in.	4	7½	7-3/4	11¾	3½-5½	6-8¼	10½	10½	8	8
Plunger speed, in./min.	1,200	187	362	690	114 min.	108 min.	108 min.	120 min.	- -	- -
Pressure on material, psi.	15,500-28,000#	20,500	20,250	22,500	20,000	20,000	19,380	20,000	20,000	20,000
Injection rate, lbs./hr.	Up to 100	70	100 max.	150 max.	6#	8.75#	8.75#	17.4#	- -	- -
Plasticizing capacity, lbs./hr.***	100	70	100	150	45	75	100	- 150	30	50
Cycles/hour	1,800 max. (actual)	360 dry	600 dry	360 dry	600-840	450-650	825-925	600-800	260;690 max.	260;690 max.
Mold: Size, in.	18x18	14x23	12x22V 14x20H	16x32V 18x30H	17x18½	12x24H 15x21V	15x25	33x33	15x9	16x10
Daylight opening, in.	10-3/4x16½	19 max.	20 max.	32 max.	5-8	6-9	8-14½	10-20	- -	- -
Thickness (min.-max.), in.	- -	- -	- -	- -	8-14	8-14	8-18	10-24	5-9	5-9
Locking force, tons	105	128	150	400	125	200	225	350	50	75
Clamping stroke (min.-max.), in.	0-10-3/4	9-15	12 max.	24 max.	8 max.	9 max.	14 max.	20 max.	- -	- -
Clamp tie bars or rods: Diameter, in.	3	3	2½	5	2½	3	3½	4½	2	2
Space between (V x H), in.	10	14½x14½	14½x12½	18½x16½	10½x12-1/8	12½x15½	15½x15½	20½x20½	- -	- -
Hopper capacity, lbs.	80	50	50	100	50	75	150	90	50	50
Cylinder heating capacity, kilowatts.	10	8.8	10	16.5	6 max.	12 max.	13 max.	21	2.8	4.2
Motor hp.	30	20	20	30	15	20	20	40	5	7½
Oil tank or reservoir capacity, gals.	135	100	150	160	120	140	120	125	- -	- -
Special features	Twin injection rams to prevent packing of material into cavity. Preplasticizing. Positive shut-off.	Suitable for insert molding. Easy rapid mold installing.	Can also be used as semi-auto. Extra-large platens. Auto. pre-pack.		Variable stroke adjustment. Speed-Flo heating cylinder.		Pre-Pac device.	- -	Volumatic feed. Stainless steel heating cylinder.	
Optional features	Choice of 3/4" & 1½" plunger diameters.		Variable clamp. Can be equipped with hydr. valves.	Automatic	Prepack & preposition device. (Gives up to 4½ oz. shots)	(Gives up to 9 oz. shots)	90 hp. motor increases injection rate to 10.7 cu. in./sec. & cycles/hr. to 975-1,100.	(Gives up to 20 oz. shots); Prepack & preposition device.	Weigh-feed L-P mold closing. Two-zone mold temp. controls. Product discharge.	
Aporox. delivery time, weeks##	4-6	From stock	4-6	4-6	5-6	5-6	5-6	5-6	12	12

On pre-plasticized materials.

Cubic inches per second.

* Complete company names and addresses are as follows:

Crown Machine & Tool Co., Inc., 2800 W. Lancaster St., P.O. Box 246. Fort Worth, Tex.
De Mattia Machine & Tool Co., Chelsea Rd., Clifton, N. J. (Distributed by Brosites Machine Co., 50 Church St., New York 7, N. Y.)
The Fellows Gear Shaper Co., Springfield, Vt.
Guy P. Harvey & Son Corp., 40 Spruce St., Leominster, Mass.
The Hydraulic Press Mfg. Co., Mount Gilead, Ohio
Improved Machinery, Inc., Nashua, N. H.
Lester Engineering Co., 2711 Church Ave., Cleveland 13, Ohio

Lombard Governor Corp., Ashland, Mass.
Moslo Machinery Co., 2443 Prospect Ave., Cleveland 15, Ohio
National Automatic Tool Co., Inc., Plastics Machinery Div., Richmond, Ind.
Newbury Industries, Inc., Route 87, Newbury, Ohio
Reed-Prentice Corp., Div. Package Machinery Corp., East Longmeadow, Mass.
Simplomatic Mfg. Co., 4416 W. Chicago Ave., Chicago 51, Ill.
Standard Tool Co., 217 Hamilton St., Leominster, Mass.
F. J. Stokes Machine Co., 5500 Tabor Rd., Philadelphia 20, Pa.
The Van Dorn Iron Works Co., 2685 E. 79th St., Cleveland 4, Ohio
Watson-Stillman Press Div., Farrel-Birmingham Co., Inc., Rochester 10, N.Y.

** Casting area is dependent on the injection pressure used for the different materials in relation to the clamping capacity of the platens, and the mold construction.

*** Plasticizing capacity varies broadly with material selection, part design, injection speed, and mold cooling.

Has more machines in addition to tabulated models.

Delivery time, as well as prices, should be substantiated in a formal quotation from the manufacturer.

Company name*	HPM*						Impco*			
Machine model	200-S-6/8	350-HV-12/16	400-HV-20/28	450-P-60	1000-P-200	1500-P-300	CE3C-75	HA1-125	HA4-175	HA8-275
Machine action	Semi-auto.	Semi-Auto.	Semi-auto.	Semi-auto.	Semi-auto.	Semi-auto.	Auto.	Auto., Semi-auto., or Manual	Auto., Semi-Auto., or Manual	Auto., Semi-Auto., or Manual
Machine type	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.
Clamping mechanism	Hydr.	Hydr.	Hydr.	Hydr.	Hydr.	Hydr.	Toggle	Hydr.	Hydr. & Toggle	Hydr.
Injection capacity, oz./shot	6-8	12-16	20-28	80	200	300	50 max.	2-3	4-6	8-10
Casting area, sq. in.**	--	--	--	--	--	--	--	--	--	--
Injection plunger stroke, in.	10	12	12	12	18	18	Pressurized valve injector.	6	8-11	9
Plunger speed, in./min.	138	160	123	130	207	225	--	--	--	--
Pressure on material, psi.	20,000 max.	20,000 max.	20,000 max.	20,000 max.	20,000 max.	20,000 max.	22,500	20,000	21,750	23,000
Injection rate, lbs./hr.	80	150	200	200	300	400	Indeterminate	750#	435#	860#
Plasticizing capacity, lbs./hr.***	80	150	200	200	300	400	60	75	75	100
Cycles/hour	--	--	--	--	--	--	150 dry	950 dry	660 dry	750 dry
Mold: Size, in.	15 x 26V 26 x 15H	20 x 34V 34 x 20H	20½ x 42V 36 x 26½H	20½ x 42V 26½ x 36H	60 x 39V 60 x 39H	48 x 72V 72 x 48H	Special	10 x 14	13 x 20	16 x 25
Daylight opening, in.	25 max.	34	40-48	40-48	65	106-120	Special	30	22-3/4	32½
Thickness (min.-max.), in.	6-10 min.	6-10 min.	9-15 min.	9-15 min.	12-20 min.	34-46 min.	Special	9-15	5-13-3/4	6-18
Locking force, tons	200 max.	350 max.	450 max.	450 max.	1,000 max.	1,500 max.	75	125	175	275
Clamping stroke (min.-max.), in.	0-15	0-22	0-25	0-34	0-45	0-60	9 adj.	3-15	4-9	5-14½
Clamp tie bars or rods: Diameter in.	4	4½	5½	6½	8	9½	3½	2½	2-3/4	3-3/4
Space between (V x H), in.	15½ x 15½	20½ x 20½	21 x 27	21 x 27	39½ x 39½	48½ x 48½	Special 13 x 10	7½x10-1/8	13½ x 12½	16-3/4 x 15½
Hopper capacity, lbs.	80	100	200	200	200	400	25	100	110	110
Cylinder heating capacity, kilowatts.	10.8	21.6	35.4	48	48	48	10	13	11	13.5
Motor hp.	30	60	75	75	180	150	15	30	20	30
Oil tank or reservoir capacity, gals.	85	120	160	185	600	1,000	30	60	60	75
Special features	--	--	Weigh-feeder	Rotary valve preplasticizing unit with positive shot-measurement.			Photo-electric re-cycling. Adj. knock-out. Electronic timers. Pre-pressurized molding. Proportional heating on cylinder.	Low-pressure closing. Adjustable knock-out. Volume feed. Proportional heating on cylinder. Multiple nozzles. Feed baffle arrangement.		
Optional features	Weigh-feeder. Control	Auto.	Auto. Control	--	--	--	Special electrical characteristics & special cycles can be provided. Pre-pressurized molding.			
Approx. delivery time, weeks##	--	--	--	--	--	--	--	--	--	--

Cubic inches per minute.

Company name*	Impco* (Cont'd.)		Lester*						Lombard	
Machine model	HA12-300	HA16-425	L-2B-4/6	L-225-6/9	L-2A-8	L-2-12	L-2-20	L-450-24/32	2414-6	3214-12
Machine action	Auto., Semi-auto. or Manual	Auto., Semi-auto. or Manual	Auto.	Auto.	Semi-auto.	Semi-auto.	Auto.	Auto.	Auto., Semi-auto. or Manual	Auto., Semi-auto. or Manual
Machine type	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.
Clamping mechanism	Hydr. & Toggle	Toggle	Toggle	Toggle	Toggle	Toggle	Toggle	Toggle	Toggle	Toggle
Injection capacity, oz./shot	12-16	20	4-6	6-9	8	12	20	24-32	6	12
Casting area, sq. in.**	--	--	50	75	110 (on 20,000 psi.)	135 (on 20,000 psi.)	200 (on 21,000 psi.)	--	110	165
Injection plunger stroke, in.	12	20	6-5/8	--	10	14	13-1/8	7.5	10	12
Plunger speed, in./min.	--	--	246	375#; 189##	171	171	150	192#; 96##	406#; 212##	234#; 156##
Pressure on material, psi.	22,400	23,200	20,000	20,000	20,000	20,000	21,000	20,000	20,000 max.	20,000 max.
Injection rate, lbs./hr.	645#	1,700#	678#	1,570#; 792##	720	720	1,056	2,880#; 1,440##	1,610#; 850##	1,110##
Plasticizing capacity, lbs./hr.***	120	200	--	--	--	--	--	--	150	150
Cycles/hour	420 dry	720 dry	approx.678 (idling)	approx.857 (idling)	approx.410 (idling)	approx.300 (idling)	approx.260 (idling)	approx.497 (idling)	900 dry	520 dry
Mold: Size, in.	19 x 25	24 x 26½	13-3/4 x 19½	16½x31½	23x31-3/4	25-3/4x28	28 x 40	26-3/4x38	14-7/8x28	20-1/8x36
Daylight opening, in.	30½	49½	21 max.	38 max.	26 max.	28 max.	35 max.	60 max.	32 max.	36 max.
Thickness (min.-max.), in.	8-18	10-25	9-12	7-22	13-16	13-16	15-21	9-30	6-18	8-22
Locking force, tons	300	425	150	225	300	400	600	450	215	325
Clamping stroke (min.-max.), in.	5½-12½	6-24½	6 - 9	8 - 16	10	12	14	8 - 30	6 - 14	8½ - 14
Clamp tie bars or rods: Diameter in.	4	4-3/4	3½	5-3/8	6½	6½	8	7½	3½	4
Space between (V x H), in.	19½ x 16	26-3/4x24½	14 x 12	17-3/8x20	23½x18½	26 x 18½	28½ x 26	27 x 25	15 x 15	20½ x 20½
Hopper Capacity, lbs.	110	110	45	50	55	100	125	175	100	100
Cylinder heating capacity, kilowatts.	16	20	10	14.7	11.1	13.6	17.25	27.5	25.5	24.4
Motor hp.	30	60	25	30	30	30	50	50	25	30
Oil tank or reservoir capacity, gals.	110	75	125	80	130	137	190	160	100	150
Special features	Low-pressure closing. Adjustable knock-out. Volume feed. Proportional heating on cyl. Multiple nozzles. Feed baffle arrangement.		Compensating feed mechanism for nylon molding. Low pressure closing. Automatic cycling. 2-pt. ejection. Stuffer.	Retractable inj. end. Stuffer. Diff. system for opening, closing, & injection. Lo-pressure closing. 2-point ejection	Compensating feed mechanism for nylon molding. 2-point ejection			Retractable inj. end. Stuffer. Diff. system for opening, closing, & injection. Lo-pressure closing.	Stuffing arrangement.	(See next page)
Optional features	Pre-pressurized molding. Special electrical characteristics & special cycles can be provided.		Pneumatic die wipers.	Mold overload compensator. Outside ejection.	Auto. cycling available. Pneumatic die wipers. Outside ejection available.			Mold overload compensator. Outside ejection.	(See next page).	
Approximate delivery time, weeks##	--	--	--	--	--	--	--	--	--	2

Cubic inches/min. ## During rapid advance. ### During final fill. ## & ### See next page.

Company name*	Lombard (Cont'd.)				Moslo					
Machine model	3220-12	3214-16	3220-16	3624-18	74-7-2	74-12-2	75-8-4/6	75-15-4/6	76-8-4/6	Duplimatic Model 11
Machine action	Auto., Semi-auto., or Manual	Auto., Semi-auto., or Manual	Auto., Semi-auto., or Manual	Auto., Semi-auto., or Manual	Auto.	Auto.	Auto.	Auto.	Auto.	Semi-auto.
Machine type	Horiz. Toggle	Horiz. Toggle	Horiz. Toggle	Horiz. Toggle	Horiz. Toggle	Horiz. Toggle	Horiz. Toggle	Horiz. Toggle	Horiz. Toggle	Vert. Toggle
Clamping mechanism	12	16	16	18	2	2	4-6	4-6	4-6	3
Injection capacity, oz./shot	165	165	165	225	24	20	54	90	54	20 max.
Casting area, sq. in.**	12	12	12	13	5½	5½	8	8	8	8
Injection plunger stroke, in.	234#; 156##	234#; 156##	234#; 156##	371#; 150##	256	256	149	149	178	153
Plunger speed, in./min.	20,000 max.	20,000 max.	20,000 max.	20,000 max.	16,550 max.	16,550 max.	20,000 max.	20,000 max.	20,000 max.	17,590 max.
Pressure on material, psi.	1,110##	1,110##	1,110##	3,570#; 1,440##	378#	378#	468#	468#	560#	317#
Injection rate, lbs./hr.	150	200	200	- -	50	50	70	70	90	50
Plasticizing capacity, lbs./hour***	520 (dry)	420 (dry)	420 (dry)	500 (dry)	1,260 (dry)	930 (dry)	700 (dry)	580 (dry)	780 (dry)	450
Cycles/hour	20-1/8x36	20-1/8x36	20-1/8x36	23-3/4x38	9 x 12	9 x 12	11-7/8x15	11-7/8x15	11-7/8x15	6 x 8 (top) 6x17 (bottom)
Mold: Size, in.	42 max.	36 max.	42 max.	50 max.	7	12	8	15	8	2½
Daylight opening, in.	8-22	8-22	8-22	8-26	5½-12	5½-12	8-15	8-15	8-15	3-3½
Thickness (min.-max.), in.	325	325	325	450 max.	60	50	135	135	150	75
Locking force, tons	8½ - 20	8½ - 14	8½ - 20	8 - 24	7	5½-12	8	8-15	8	2½
Clamping stroke (min.-max.), in.	4	4	4	4½	1-3/4	1-3/4	2½	2½	2½	- -
Clamp tie bars or rods: Diameter, in.	20½x20½	20½x20½	20½x20½	23-7/8 x 21-7/8	6-3/4x9½	6-3/4x9½	11x12-1/8	11x12-1/8	11x12-1/8	- -
Space between (V x H), in.										
Hopper capacity, lbs.	100	100	100	100	75	75	75	75	75	75
Cylinder heating capacity, kilowatts	24.4	24.4	24.4	25.5	6	6	7	7	8	6
Motor hp.	30	30	30	50	7½	7½	10	10	15	5
Oil tank or reservoir capacity, gals	150	150	150	150	58	58	77	77	90	90
Special features	Stuffing arrangement. Plunger advance. Hydraulic positioning of injection & linkage units. Hi-speed plunger prefil. Dual inj. pressure controls. Water-cooled plunger.				Heat controls on cylinder & nozzle. Modified J.I.C. control circuit. Plug-in controls.					Shifting table for dual lower mold platen permits two-section molding & continuous operation.
Optional features	Pre-compressed molding unit. Hi-speed injection unit. Nylon shut-off valve. 2-4 nozzle attachments. Mold stop control. Mold slow-down. Core pulling.				70-lb. plasticizing cylinder.		90-lb. plasticizing cylinder.			
Approx. delivery time, weeks##	2	2	2	- -	2	2	4 - 6	4 - 6	4 - 6	2

Cu. in./min. during pre-fil or approach.
Cu. in./min. while injecting.

* Cubic inches per minute.

Company name*	Natco						Newbury			
Machine model	300	400	400-S	400-X	800	800-X	"Wasp" Model 45	"Wasp" Model 50	"Hornet" Mini-Matic	Super "Hornet"
Machine action	Semi-auto.	Semi-auto.	Semi-auto.	Semi-auto.	Semi-auto.	Semi-auto.	Manual; bench	Manual	Auto.	Manual
Machine type	Horiz. Hydr.	Horiz. Hydr.	Horiz. Hydr.	Horiz. Hydr.	Horiz. Hydr.	Horiz. Hydr.	Vert. "V" wedge	Vert. "V" wedge	Horiz. Air toggle	Horiz. Hydr.toggle
Clamping mechanism	Single/double feed.						1/3-3/4	1/3-1	1/3-3/4	1/3-1
Injection capacity, oz./shot	22-30	28-34	28-34	28-34	85-100	85-100	6 max.	6 max.	6 max.	6 max.
Casting area, sq. in.**	Depends upon part design and plastic material used.						6	6	6	6
Injection plunger stroke, in.	15	15	15	15	21	21	- -	- -	- -	- -
Plunger speed, in./min.	160	119	119	252	102	204	4,700-21,600	6,300-30,000	6,400-21,600	6,300-30,000
Pressure on material, psi.	20,000-130	20,000-165	20,000-165	20,000-165	20,000-350	20,000-350	- -	- -	- -	- -
Injection rate, lbs./hr.	1,125#	1,140#	1,140#	2,420#	2,000#	4,000#	5.5	5.5	5.5	5.5
Plasticizing capacity, lbs./hr.***	130	165	165	165	350	350	180	180	480 (dry)	360
Cycles/hour	Estimated cycle time furnished upon receipt of plastic part specification.									
Mold: Size, in.	33x21½ max.	38x24-3/4 max.	38x24-3/4 max.	38x24-3/4 max.	55x36½ max.	55x36½ max.	4½x2x2-5/8; 6x2x2-5/8	4½x2x2-5/8; 6x2x2-5/8	6x5-1/8x5	6x5-1/8x5
Daylight opening, in.	32-41½ max; 8-18½ min.	38-50 max; 12-24 min.	36-48 max; 10-22 min.	38-50 max; 12-24 min.	55-85 max; 25-45 min. (in 5-inch increments.)	55-85 max; 15-45 min.)	- -	- -	3½	3½
Thickness (min.-max.) in.							1-1/32-2-1/16	1-1/32-2-1/16	2-3/8-5-1/8	2-3/8-5-1/8
Locking force, tons	325	425	550	425	850	850	- -	- -	10 approx.	12 approx.
Clamping stroke (min.-max.), in.	24	26	26	26	40	40	- -	- -	- -	- -
Clamp tie bars or rods: Diameter, in.	4½	5	6	5	7	7	- -	- -	1	1
Space between (V x H), in.	21½ x 21½	25 x 25	25 x 22	25 x 25	36½ x 36½	36½ x 36½	- -	- -	6½	6½
Hopper capacity, lbs.	100	200	200	200	500	500	4	4	8	4
Cylinder heating capacity, kwts.	16	24	24	24	40	40	0.55	0.55-0.75	0.55	0.55-0.75
Motor hp.	47½ total	47½ total	47½ total	87½ total	82½ total	157½ total	- -	1 or 2	- -	1 or 2
Oil tank or reservoir capacity, gals.	175	175	260	260	550	550	- -	- -	- -	- -
Special features	Water-cooled plunger. Adjustable two-speed, two-pressure injection. Pre-pack and preposition. Vibratory feed. Signal lights for heater bands. Reversing-type pump with shockless system.						6-inch air cylinder. 1/2-, 5/8-, 3/4-, and 7/8-inch injection rams.	1/2-, 5/8-, 3/4-, 7/8-, & 1-1/16-inch injection rams.	6-inch air cylinder. 5/8-, 3/4-, 7/8-inch injection rams.	1/2-, 5/8-, 3/4-, 7/8-, & 1-1/16-inch injection rams.
Optional features	Weigh feeder. Nozzle for nylon molding. Plunger & feed bushing for 17,500 or 30,000 psi. pressure. Automatic cycle control with low-pressure mold protection.						Fabricated steel stand.			Mini-Temp.
							Air mold ejector.			
Approx. delivery time, weeks##	Built in stock quantities for prompt delivery.						3 - 4	3 - 4	4 - 6	3 - 4

* Cubic inches per minute.

Company name*	Newbury (Cont'd.)		Reed-Prentice*						Simplo-matic	Std. Tool
Machine model	Standard "Eldorado" Model 70 VC 95	Super "Eldorado" Model 70 VC 105	175T-4/6	Jet Flo "6"	275T-8/10	300TA-12/16	450T-20/24	600T-32/48	Pro-1-57 Little Giant	Automolder SP2C-25-T
Machine action	Semi-auto.	Semi-auto.	Auto.	Auto.	Semi-auto.	Semi-auto.	Semi-auto.	Semi-auto.	Auto. Bench Model	Auto.
Machine type	Vert.	Vert.	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.	Vert.	Horiz.
Clamping mechanism	Hydr. Toggle	Hydr. Toggle	Toggle	Toggle	Toggle	Toggle	Toggle	Toggle	Pneumatic	Hydr.
Injection capacity, oz./shot	1/3-1½	1/3-1½	4 - 6	6	8 - 10	12 - 16	20 - 24	32	1/3	2
Casting area, sq. in.**	6 max.	6 max.	75	75	125	150	200	300	6	20
Injection plunger stroke, in.	8	8	8-7/8	6	11	13	13	10	2½	4
Plunger speed, in./min.	- -	- -	175;312#	155;1,200#	148;329#	131;211#	100;267#	58.1;117#	Unknown	Approx. 2.5###
Pressure on material, psi.	4,425-21,000	4,425-21,000	17,800	17,000	20,000	20,000	21,000	19,350	7,000 max.	14,000-26,000
Injection rate, lbs./hr.	- -	- -	492##	1,160##	801##	925##	962##	1,450##	6#	390##
Plasticizing capacity, lbs./hr.***	5.5	5.5	75	100	120	130	150	180	6	30;40
Cycles/hour	360	360	600 max. Full stroke	1,242 max. Full stroke	470 max. Full stroke	360 max. Full stroke	200 max. Full stroke	172 max. Full stroke	500 max. (dry)	1,200 (dry)
Mold: Size, in.	6x5-1/8x5	6x5-1/8x5	22 x 13½	22 x 13½	22½ x 14½	29 x 20½	45 x 25½	54 x 30½	3½ x 5½	9 x 10 max.
Daylight opening, in.	4-7/8	4-7/8	22	22	26½	32½	40	56	2½	12-3/4 max.
Thickness (min.-max.), in.	2-3/8-5-1/8	2-3/8-5-1/8	6 - 14	6 - 14	6½ - 16	8 - 20	7 - 24	12 - 32	2½	6 min.
Locking force, tons	18 approx.	18 approx.	175	175	275	300	450	600	3½	25
Clamping stroke (min.-max.), in.	- -	- -	5 - 8	5 - 8	6½ - 10½	7½ - 12½	7 - 24	24	- -	0-6-3/4#
Clamp tie bars or rods: Diameter, in.	1	1	3	3	3½	4	5	6	- -	- -
Space between (V x H), in.	6½	6½	13½ x 13½	13½ x 13½	11½ x 14½	15 x 20½	22½ x 25½	26½ x 30½	- -	9-3/8 x 12
Hopper capacity, lbs.	4	4	100	150	150	150	150	150	5	125
Cylinder heating capacity, kwts.	0.55-0.75	0.55-0.75	13.6	15.4	17.0	21.7	30.3	24.1	0.65	3.15
Motor hp.	2	2	15	40	25	30	40	50	- -	15
Oil tank or reservoir capacity, gals.	- -	- -	80	100	150	150	150	200	- -	60
Special features	5/8-, 3/4-, 7/8-, and 1-1/16-inch injection rams.		2-stage injection. Built-in stuffing.	- -	2-stage injection. Built-in stuffing.				Operates on 100-125 psi. air line. Auto. shut-off valve in cyl. Auto. cyl. & mold temp. controls. Auto. ejection. Higher cycling speeds.	(See continuation for all 3 models.)
			Automatic ejection.							
			Zoned temperature control.							
			Adjustable mold stroke.							
Optional features	- -	- -	Larger heating cyl.	- -	Larger heating cyl.					
			Low-pressure die closing. (Std. on Jetflo)							
			Nylon molding equipment.							
			Long stroke up to 12 in.			Long stroke up to 20 in.				
Approx. delivery time, weeks#	4 - 6	4 - 6	- -	- -	- -	- -	- -	- -	2 - 3	4 - 5

with pre-fill. ## Displacement rate.

#Plasticizing capacity.

(See continuation.)

Company name*	Std. Tool (Cont'd.)		Stokes			Van Dorn				
Machine model	Automolder SP-20-100TA	Automolder SP-20-100TB	701	700	703	H-200	H-250	H-260	H-300	H-400
Machine action	Auto.	Auto.	Auto. (Vertical Clamp	Auto. (Horiz. Straight	Auto. Vert. Clamp	Semi-auto.	Auto.	Auto.	Auto.	Auto.
Machine type	Horiz.	Horiz.	Toggle	Hydr.	Toggle	Horiz. Toggle	Horiz. Toggle	Horiz. Toggle	Horiz. Toggle	Horiz. Toggle
Clamping mechanism	Hydr.	Hydr.								
Injection capacity, oz./shot	2	2	2	4	6	2	2½	2½	3	4
Casting area, sq. in.**	40	60	20	48	100	20	20 plus	20 plus	- -	75 - 150
Injection plunger stroke, in.	4	4	4½	8	9	7	7	7	6½	7
Plunger speed, in./min.	Approx. 2.5###	Approx. 2.5###	200	360	260	225	270	270	300	175##
Pressure on material, psi.	14,000-26,000	14,000-26,000	12,100	16,000	19,600	10,000	12,000	12,000	15,000	20,000
Injection rate, lbs./hr.	390##	390##	40	60	90	12	22	30	75	100
Plasticizing capacity, lbs./hr.***	30;40	30;40	45	60	90	12	22 plus	30 plus	75	100
Cycles/hour	2,000 (dry)	2,000 (dry)	1,030	515	495	480-600	720 max.	720 max. (dry)	1,200 max. (dry)	840 max. (dry)
Mold: Size, in.	9x10 max.	9x10 max.	14 x 8½	21 x 12	23½x14-7/8	8x10 max.	9x12 max.	9x12 max.	9-7/8x14max.	13-3/8 x 29½ max.
Daylight opening, in.	18 max.	12-3/4 max.	14 -20½	21-3/4	26-34	6	6	6	4-8;4-12	- -
Thickness (min.-max.), in.	9 min.	6 min.	8½ - 15	8 - 13-3/4	28½-36½	8¼ x 3	8½ x 3	8½ x 3	4-12;6-14	6 - 16
Locking force, tons	100	100	50	120	250	27	30	30	70;60	175
Clamping stroke (min.-max.), in.	0-6-3/4#	0-5#	5½	14	12	6#	6#	6#	4 - 8#	4 - 10#
Clamp tie bars or rods: Diameter, in.	- -	- -	1-3/4	3½	4½	1-3/4	1-3/4	1-3/4	- -	2-3/4
Space between (V x H). in.	9-3/8x12	9-3/8x12	17-3/4 x 6-3/4	12 x 12	24 x 10	9	9	9	- -	13½x12-1/8
Hopper capacity, lbs.	125	125	30	60	85	6	20	20	- -	65
Cylinder heating capacity, kwtts.	7.9	7.9	5.4	6	17.3	1.68	2.6	3.135	- -	- -
Motor hp.	15	15	7½	15	20	5	7½	7½	15	20
Oil tank or reservoir capacity, gals.	60	60	70	40	150	20	20	20	- -	80
Special features	Heat controls. Instrument stand. Cam-operated, mechanical drive for timing. Third pyrometer for hot-runner molds. Low-pressure closing. Auxiliary air sweep to aid positive ejection.		Injection nozzle shut-off. Prepack. Positive ejection.			Automatic part ejector. Oil cooler and cylinder heater. Adj. material metering. Oversize heater.				
							Low-pressure clamping. Extended nozzle. Can mold vinyls.		One-shot lubrication system.	
						Adjusts to varying mold thicknesses.				

(CONTINUED ON FOLLOWING PAGE)

Company name*	Std. Tool (Cont'd.)		Stokes (Cont'd.)			Van Dorn (Cont'd.)				
Machine model	Automolder SP-20-100TA	Automolder SP-20-100TB	701	700	703	H-200	H-250	H-260	H-300	H-400
Special features (cont'd.)									8-inch stroke. Four tie-bar construction	Double toggle lock. Stuffing arrangement.
Optional features			None required.			Repeat cycle timer. Can mold vinyls.			Repeat cycle timer.	
									4-12 in. adjustable stroke. Low-pressure closing. Weigh feeder.	
Approx. delivery time, weeks##	4 - 5	4 - 5	3-4 Aver.	3-4 Aver.	- -	4 - 6	4 - 6	4 - 6	4 - 6	4 - 6

Controlled by die height or by insertion of spacer blocks.
Cubic in./minute.
Inches per second.

Not adjustable.
Adjustable.
At full pressure.

Company name*	Watson-Stillman*					
Machine model	5KS-215	10-KS-300	16KS-400S	24KS-425	32KS-650	48KS-1000
Machine action	Manual, Semi-auto., & Auto.	Manual, Semi-auto., & Auto.	Manual & Semi-auto.	Manual & Semi-auto.	Manual & Semi-auto.	Manual & Semi-auto.
Machine type	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.	Horiz.
Clamping mechanism	Hydr.	Hydr.	Hydr.	Hydr.	Hydr.	Hydr.
Injection capacity, oz./shot	5 max.	10 max.	16 max.	24 max.	32 max.	48 max.
Casting area, sq. in.**	107	150	200	212	325	500
Injection plunger stroke, in.	9	12	12	14½	14½	18½
Plunger speed, in./min.	205;550##	210;400##	195;400##	174;400##	130;400##	200;325##
Pressure on material, psi.	20,000	20,000	22,500	20,000	20,000	21,000
Injection rate, lbs./hr.	1,160#	1,240#	1,518#	1,795#	1,737#	3,360#
Plasticizing capacity, lbs./hr.###	80	140	150	250	300	500
Cycles/hour	600	550	480	400 max.	350 max.	300 max.
Mold: Size, in.	15-3/4x25½ max.	20½ x 36 max.	20x36 max.& 21x33 max.	27x45 & 25x40½	27x45 max.& 27x43½	40 x 60
Daylight opening, in.	24-30	30	34	40	54	66
Thickness (min.-max.), in.	12 min.	12 min.	12 min.	16 min.	12 min.	12 min.
Locking force, tons	215	300	400	425	650	1,000
Clamping stroke (min.-max.), in.	12 max.	18 max.	22 max.	24 max.	30 max.	36 max.
Clamp tie bars or rods: Diameter, in	3-3/4	4	4½	4-3/4	6	7½
Space between (V x H), in.	15-3/4 x 15-3/4	20½x20½	20 x 21	27 x 25	27 x 27	40 x 40
Hopper capacity, lbs.	50	100	150	200	200	250
Cylinder heating capacity, kwts.	9.8	12	20.65	26	29	52.3
Motor hp.	50	90	70	70	70	135
Oil tank or reservoir capacity, gals.	100	150	240	250	260	540
Special features	Low-pressure die closing. Adjustable slow-down on clamping stroke. Pre-positioning of injection ram. Stuffer circuit by selector switch.					
Optional features				Low-pressure die closing.		
	Pre-plasticizing unit can be added. Weigh-feeders.					
Approx. delivery time, weeks##	3 - 4	6 - 8	3 - 4	2 - 4	2 - 4	8 - 10

Cubic inches per minute. ## Plunger return.

Classified List of Auxiliary Equipment

Drying Ovens

Ball & Jewell, Inc.
Blaw-Knox Co.
G. S. Blodgett Co.
E. B. Blue Co.
Brosites Machine Co., Inc.
Cleveland Process Corp.
Arthur Colton Co.
F. C. Dawson Engineering Co.
Despatch Oven Co.
J. E. Doyle Co.
Drying Systems Co.
Dryomatic Corp.
Eclipse Fuel Engineering Co.
Falcon Equipment Co.
Finn & Fram
Foremost Machine Builders, Inc.
Glenn Electric Heater Corp.
Grieve-Hendry Co., Inc.
Injection Molders Supply Co.
Lydon Brothers, Inc.
Michigan Oven Co.
The Miskella Infra-Red Co.
Proctor & Schwartz
Radiant Heat Enterprises, Inc.
The Rainville Co., Inc.
W. S. Rockwell Co.
Somerset Industrial Designs, Inc.
Stromes Systems, Inc.
Thermomat Co., Inc.
Thoreson-McCosh, Inc.
John Waldron Corp.
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(Continued on next page)

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Battenfeld (West Germany),
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Danielson, Conn.

Guest Editorial

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Plastic Sales Div., Phillips Chemical Co.
Bartlesville, Okla.

Technical Services—

Responsibilities of Resin Supplier

LIVING in a land of plenty with over-production would sound like heaven to many peoples of the world, and I am sure that little sympathy could be created for the resin supplier who finds himself in this predicament. Fortunately, resin manufacturers are familiar with this situation and face the responsibilities with confidence. Any basic raw material manufacturer has three responsibilities—research, production, and sales—all of which are vital for complete success. These three responsibilities should be kept in balance. To do so is stimulating but difficult, and taxes every bit of ingenuity that a progressive company has.

In this changing and expanding universe, research is a necessity. Although it is one of the primary factors which have contributed to our increased national productivity, it also has created many problems for sales. The advent of practically every new resin has gone through such a cycle. The research which creates, develops, and puts a resin into production leads directly to a program of education. This is designed to acquaint the potential customer with the resin properties, special processing and engineering methods, and with matters of costs and economic considerations. This is technical information. Special services are required that are aimed positively at the attainment of useful results and final sales. This responsibility was assumed by the basic resin supplier beginning with the early phenolic plastics, and the idea that high-quality scientific thinking is required in the application of these new resins, as well as in the making of them, is firmly entrenched. The proven success of technical service in bettering a supplier's business by bettering a customer's business is self-evident.

For the resin supplier, the problem of supplying technical information and services is more difficult than assuming the responsibility.

Dr. Vannevar Bush has pointed out: "Here, there is a real problem of management, and a real opportunity. This problem consists of three parts: first, having a smoothly operating group, with adequate, well chosen facilities, good internal communications, and satisfactory housekeeping; second, a means for determining intelligently the subjects that are to be worked on; and third, an interrelation between groups so that projects which start with an idea, become abandoned if proven abortive, or otherwise emerge reasonably promptly and in a form that is genuinely valuable."

How do we approach this challenge? We at Phillips

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orientation, to ease dielectric preheating, air reduce entrapment, reduce material bulk factor so that large loading cavities are not needed, and facilitate material handling in the loading of molds. Some of the DAP molding compounds have high bulk factors (see Table 1) and must be preformed in high bulk-factor machines or on hand-operated preforming equipment. Nevertheless, such operations often are economically advisable, and these materials generally can be made into good preforms. Sometimes, the warming of preform dies to 100-120° F. is helpful.

Pressures of 500-2,000 psi. are given by the manufacturers as being required for the compression molding of these materials. In general, these values are reasonable for the softer-flow compounds, but pressures of up to 5,000 psi. may be required for materials of stiffer flow.

Transfer-molding pressures calculated on the basis of the load applied to the transfer pot area normally vary from 2,000-10,000 psi., depending on the type of material and part. Glass-filled DAP materials show extremely good flow characteristics in intricate cavities, whereas organic fiber-filled materials are more difficult to transfer. Good mold venting in transfer molds is essential; also, adequate draft and large ejector surfaces should be used.

The DAP materials are quite weak at molding temperatures, and parts made from them may break or deform during ejection unless adequate precautions are taken. In cavities with a large number of pins, the part often will shrink tightly onto the pins and break upon ejection. This situation often can be remedied by increasing the cure time, thereby decreasing the shrinkage and permitting the part to release.

Molding Defects

Blisters sometimes present a problem in molding DAP materials. Preforming, preheating, and proper cure times usually help to overcome blistering.

Porosity may occur in DAP moldings. Two types of porosity have been described previously (3). It is thought that the "fissure" type is caused principally by trapped air, and that the "sponge" type is due mainly to absorbed volatiles which are released during cure. Fissure-type porosity usually can be overcome by performing and/or preheating the material prior to molding.

Sponge-type porosity is rare in DAP materials and, theoretically, should not occur because of the addition-type polymerization involved. Occasionally, "gassy" materials may be encountered which contain large amounts (more than 1%, by weight) of adsorbed volatile material. High volatile content may result if an excessive amount of solvent (usually acetone) remains in the material after formulation, or from storage in extremely humid conditions. This situation often can be corrected by the use of pre-drying and pre-heating techniques.

In extremely critical military applications, very small amounts of internal porosity may be sufficient to render the part useless. A good non-destructive test for internal porosity is the evaluation of X-ray photographs of the parts. When complete homogeneity of the part is essential, very strict quality control of the raw material is necessary. Often, it will be found that only a limited variation in flow, volatile content, and particle-size distribution can be tolerated. Also, the molding process must be controlled rigidly. Variations in mold temperature, mold-closing cycle, and molding pressure may cause imperfections in the part not detectible by visual inspection. Another requirement for dense moldings is that the flash restriction be minimized in order to permit maximum effective pressure on the part during molding.

Poor fiber orientation can create difficulties in parts molded from compounds containing long, fibrous fillers. Adjustment of fiber length in proportion to molded-part thickness, and proper flow of material in molding as a result of correct placement of mold charge, preforms, etc., both help to correct poor orientation.

In transfer molding, white spots and charred areas may occur. The white spots, thought to be volatile or air inclusions, show up readily in pigmented materials. These usually can be eliminated by predrying, preheating, or mold venting. Charred areas sometimes occur at points where air is trapped and then heated to the charring point as a result of compression by the flowing material. Venting of the mold at the trouble-point usually will eliminate charring.

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—THE END

**Technical Services —
Responsibilities of Resin Supplier**
(Cont'd. from page 55)

are fortunate in having technically-qualified men as sales engineers backed up by a strong, central, fundamental research and development organization. Technical services and development, then, do the following:

(1). Render technical services to the customer. This may vary from simply furnishing fundamental data on a product to assisting in designing, building, or modifying a mold, and to actual operation of equipment in a customer's plant. There is no limit to the extent that this service may be required, or what form it may assume.

(2). Develop new applications and new techniques for using existing products.

(3). Prepare technical information for salesmen, customers, advertising, and promotion.

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Engineering Thermoplastics for Ocean Telephone Cables

Important factors in engineering thermoplastics for marine telephone cables are discussed, together with an outline of future materials studies anticipated.

SEPTEMBER 25, 1956, marked an important milestone in communications history. On that day, the first telephone cable linking North America with the British Isles and Europe was put into service as the culmination of a joint enterprise by American Telephone & Telegraph Co., the British Post Office, and Canadian Overseas Telecommunications Corp. Previously, there had been only radio-telephone service over this route, and the new cable provided the first circuits with quality and reliability comparable with present land lines.

This cable marked the beginning of a new era in undersea communications art, an era in which plastics can be expected to have a key role, not only as the electrical insulation of the transmission line as in the present cable design, but also in critical components of the amplifiers or repeaters necessary for transmission over the great distances involved, and quite possibly as the outer protective covering of future ocean cables.

Cable Construction

The features of present-type cable systems, will not be discussed in detail here, since they have already been well described in earlier papers (1-13).* It may be helpful, however, to consider briefly the physical construction of the cable itself, since this discussion is primarily concerned with problems involved in selecting plastics to go into structures such as these.

In Figure 1, the construction of the D-type or deep-water cable used in the first transatlantic system is shown. Similar cable also was used in the Alaskan, Hawaiian, and second trans-Atlantic systems. The electrical member is a coaxial structure consisting of a copper wire, 0.1318-inch in diameter, enveloped in a helix of three copper-surrounded tapes each 0.148-inch wide and 0.0145-inch thick. These tapes are intended to provide continuity of circuit in the unlikely event

*Numbers in parentheses refer to Bibliography at end of article.

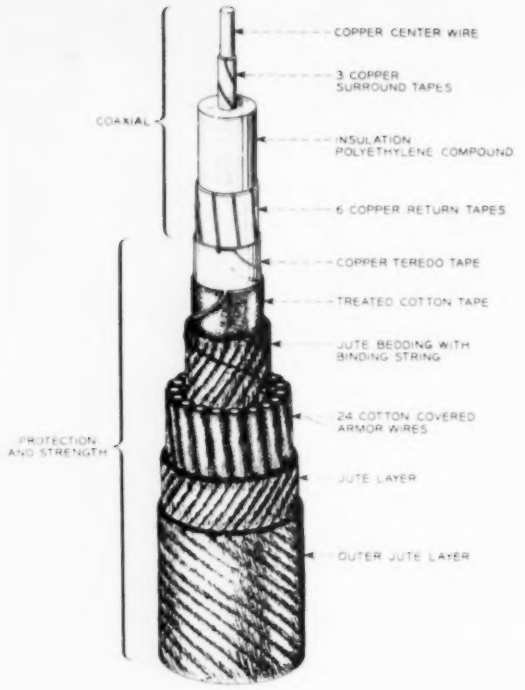


Fig. 1. Construction of deep-water cable used in trans-Atlantic telephone system.

of a break in the solid center wire. The dielectric is a 0.620-inch O.D. layer of high molecular-weight polyethylene compounded with 5%, by weight, of butyl rubber. The coaxial structure is completed by a helix of six copper return tapes, 0.320-inch wide by 0.016-inch thick, spiralled around the dielectric.

Outside the electrical member are the protective and strengthening layers, most of which are substantially the same as those used since the inception of submarine cable art in the middle of the last century. First is the teredo tape, an overlapped helix of three-mil copper tape 1.75-inches wide, intended to prevent damage to the insulation by marine borers. Next is a treated-cotton binder tape; then, a single serving of cutched jute to serve as bedding for the 0.086-inch high tensile steel armor wires.

Despite their name, the primary function of these wires in this type of cable is to provide strength for handling, laying, and possible recovery of the cable.# Two servings of coal tar-impregnated jute over the armor wires constitute the outer layers of the cable. There is, then, little to impede the ready access of seawater to the outside surface of the polyethylene dielectric, and this is a "wet core" cable. In fact, it is kept in water continuously after the final stages of manufacture, except for brief periods while being transferred into and out of the holding tanks aboard the cable ship.

Once installed in the depths, this cable is obviously inaccessible. Should repairs prove necessary, they are both difficult and expensive. Far more extensive precautions, therefore, are exercised in selecting and handling the various materials involved in its construction than would be taken for land cable, all directed toward the single end of producing as sound a structure as is physically possible with every expectation of a very long service life. Much of this precaution centers, of course, around attempts to keep contaminants out of and away from the polyethylene insulation that is the electrical heart of the cable.

For example, copper substantially free from residues of the lubricants normally used in drawing and rolling operations is required because most of these compounds can be shown to be active cracking agents for polyethylene. While lubrication is essential to the working of the metal, only those which do not affect the dielectric are considered satisfactory. Similarly, even though jute normally does not come into direct contact with polyethylene of the cable core (under the safety precautions for submarine cable), the spinning oils and saturants used in their preparation likewise are screened for possible effect on polyethylene.

Electrical Properties

In the case of the insulating compound itself, rigid requirements are instituted to safeguard those characteristics considered critical, while less stringent limits are accepted for more routine properties. The transmission characteristics of the cable, of course, are strongly dependent on capacitance. When the dimensions of the structure are held constant, capacitance is proportional to the dielectric constant of the insulating material. In the manufacture of this ocean telephone cable, the extruder is under the control of an automatic device which continuously monitors both the diameter and the capacitance of the extruded core and which corrects, through a feedback system, for deviations. Close control of cable capacitance, in practical terms, means maintenance of the dielectric constant of the insulating compound within very close limits, so close as to require a special test procedure.

In essence, the method consists of measuring the capacitance of a fixed-plate condenser immersed at a precisely-known temperature in pure, dry benzene within a gold-plated cell, using a precision bridge or equivalent equipment. Most of the benzene between the plates of the condenser is then displaced with sheets of polyethylene compound and the change in capacitance of the system determined. Because the permittivity of pure dry benzene at a given temperature is known very precisely from the literature and because this permittivity is very close to that of the insulating compound, the change in capacitance of the test cell upon insertion of the polyethylene sheets is minimized, and the dielectric constant of these sheets can be calculated accurately from the capacitance change read directly on the vernier scale of the test instrument.

The need for low dissipation factor in the insulant of a low-loss cable is so self-evident that it needs no discussion here. The maximum of 0.0005 is met easily by any clean, unpigmented A.S.T.M. Type I polyethylene, (0.92 density) which normally measures 0.0001-0.0003. It might be worth while to point out, however,

#In cable designed for use in shallow water where chance of damage from tidal action on rocky bottoms or from anchors and fishing gear may be high, larger armor wires are used to provide better protection against abrasion, crushing, or cutting. In A-type cable, one of the types used for shore ends, these wires are 0.300-inch diameter mild steel, for example.

that the frequency chosen for this test should lie preferably within the intended operating band of the cable, particularly if this is to include the low kilocycle range of frequencies.

The milling stability requirement provides verification of the concentration and quality of the anti-oxidant present in the insulating compound. A quantitative chemical test, while desirable and more informative, would actually serve but little better here, since what is wanted is a factual guarantee that compound emerging from the extruder as cable insulation will have survived the thermal exposure during processing without damage. This test has been part of telephone and certain military polyethylene specifications for many years, and now appears also in the proposed Federal Specification LP-590 and in ASTM Method D1248-58T. (It involves working the material in a specified manner on a 6- x 12-inch, two-roll laboratory mill at 160° ± 5° C. for three hours, after which the original dielectric requirements must again be met.) Unstabilized or inadequately-stabilized compound will not pass this test. Since the conditions imposed are substantially more vigorous from the oxidation standpoint than those which exist in most extruders, materials meeting this requirement in all probability are thermally-stable in normal extrusion.

Cable Contamination

Contamination level is a very important property in the eyes of submarine cable engineers. Foreign inclusions, even very small ones, continue to be the cause of great concern as possible threats to the life of the cable when subject to high voltage stresses. In principle, inclusions whose dielectric constants or conductivities differ greatly from that of the surrounding matrix could lead to electrical stress concentrations conducive of premature breakdown. Mason (14,15) has shown this to be so when the inclusions are voids, and Hunt, Koulopoulos and Ware (16) have reported more recently on the deleterious effects of solid inclusions. The voltages presently used in repeatered submarine telephone cable are moderately high. The first transatlantic cable, for example, is operating with approximately 2,000 volts D.C., both above and below a neutral ground. While these voltages are below the presumed corona level in polyethylene, they are high enough to cause concern.

Total exclusion of foreign bodies from the dielectric of the cable core is the obvious goal, but it does not appear possible to achieve in practice, as yet. However, the nature and level of contamination remaining in the best commercial insulating compounds today already is low enough to present mechanical problems in specification and inspection control, even though not low enough to satisfy the critical cable engineer. The problems involved are not unlike those of finding the traditional needle in a haystack. A single "malignant" inclusion could incapacitate the entire 4,000-mile transatlantic cable system, but consider the task of finding that inclusion in more than two and two-thirds million pounds of compound!

The obvious approach, of course, is to equip the insulating extruder with an effective strainer or filter, and this technique is being employed. However, there are very real limits to the amount of such impedance that can be tolerated by the extrusion equipment; therefore, good control over the cleanliness of the compound (as furnished) is essential.

Five cubic-inch samples are taken from each material container in a given lot and are examined over a suitable light source as sheet approximately 0.050-inch thick. No inclusions larger than 0.065-inch in their greatest dimension are permitted, and no five cubic-inch sample may contain more than one foreign inclusion between 0.016- and 0.065-inch in largest dimensions, or more than 15 inclusions in the size range 0.007-0.015 inch. Although this represents a high level of sanitation by usual commercial standards, it still leaves much to be accomplished for the ultimate in this very exacting application. Work with the suppliers toward attaining cleaner compounds is continuing.

Fig. 2. Cracking of high-density polyethylene cable insulation in tests.

Stress-Cracking

Environmental stress-cracking of polyethylene, first observed in the laboratory by Richards (17) and in the field by Wallder and his associates (18) is now only too familiar to many users of polyethylene. Stress-cracking results from the action of certain agents, usually surface-active in nature, on polyaxially-stressed polyethylene (19). The catastrophic consequences should it take place in the dielectric of an ocean telephone cable are obvious. While there is as yet no evidence of anything in sea water, in ocean-bottom sediment, or in any by-product of marine biological activity that is inimical to polyethylene in this regard, the characteristic conservatism of the submarine cable engineer demands positive assurances against the occurrence of this phenomenon.

Specification of high molecular-weight polyethylene and its compounding with butyl rubber are intended as such safeguards. The former is controlled satisfactorily for practical purposes by the melt-index requirement. The incorporation of 5% butyl rubber into the compound introduces tiny internal "cushions," presumably in the form of very minute droplets of butyl rubber dispersed throughout the mass of compound. These two materials apparently are not truly compatible, even above the crystalline melting point of the polyethylene where they display a limited miscibility. As the extruded compound cools, the butyl rubber presumably separates out in sub-microscopic pockets. These "shock absorbers" tend to equalize and dissipate externally-applied stresses (as when the cable is flexed or bent), rendering it difficult for stress concentrations to be built up at any point to a level at which environmental cracking could come into play.

The method used to test for adequate resistance to environmental stress-cracking for specification purposes is the now familiar bent-strip procedure devised by DeCoste, Malm, and Wallder (18). For submarine cable purposes, more rigid limits are imposed than are used ordinarily for land cable sheath or for most other purposes, where failure in two of 10 specimens in 48 hours is considered satisfactory. For the more exacting requirements of submarine cable, a much more severe test is imposed. The test specimens are preconditioned in an unstrained condition for seven days at 70° C. They are nicked, bent in the standard manner, and immersed in concentrated Igepal CO-630 at 50° C. No failures are permitted in 10 specimens after seven days. It is of interest to note that the 5% butyl rubber and high molecular-weight polyethylene compound now in use has never shown a single failure in this test, to our knowledge.

We have indicated that the melt-index requirement provides a measure of practical control over the molecular-weight range of the insulating compound. In conjunction with melt-index recovery, it also provides an indication of processability in that compounds with similar recovery values (those whose melt index lie near the upper end of the permitted range), can be expected to extrude more easily. As noted earlier, melt-index recovery serves to place an upper limit on the amount of elastic memory or "nerve" in the raw material. While this characteristic can be modified in extrusion, the magnitude of modification (and perhaps even its direction) can vary appreciably with the nature of the equipment and process used. From the standpoint of absolute dimensional stability, it is desirable to have the extruded insulation devoid of internal strains which could relax slowly over very long periods of time, with resultant changes in vital core dimensions. Such changes, however small, are definitely unwanted by the cable engineer because they would represent changes in transmission loss with time, for which the cable system has very little tolerance. The melt-index recovery requirement, although it can do nothing to control the amount of shear energy impressed upon the insulating compound in the extrusion process, at least can limit its ability to store such energy in a meta-stable state for eventual release by means of a slow creep mechanism.

Newer Materials

Embodied in the type specification is the essence of plastics technology as it applies to ocean telephone cable today. Limited in scope at present to the primary electrical insulation of the coaxial, it is a technology which looks forward to broader fields of application in the submarine cables of the not-too-distant future. Some of the new, harder polyethylenes, for example, suggest themselves as outer coverings potentially more abrasion- and cut-resistant than the jutes of Cyrus Field's 1866 design. Insofar as non-electrical features are concerned, these jutes remain the prototype for today's ocean telephone cable. These new materials are worthy of more than passing comment.

Harder, more crystalline, more dense olefin polymers made by several different processes have become available. Products from different sources or produced by process variations have quite different properties in some respects, but also appear to have certain characteristics in common. The abrasion resistance, for example, usually varies in an orderly fashion with density of the polymer. Abrasion testing is a complex art, and test results have little meaning except in association with the method by which they were obtained. It is possible, for example, to rate three materials in any of the possible orders by proper choice of perfectly legitimate tests.

Many of these newer olefin polymers display a characteristic, unfamiliar in standard polyethylenes, which must have decided bearing on their applications in communications work. Figure 2 shows a #22 AWG copper conductor insulated with a 30-mil wall of a high-density or linear-type hydrocarbon polymer. Immediately after extrusion, the insulated wire could be wrapped around itself without damage. After a few hours in air at 100° C., or a few days in air at 70° C., however, this insulation became so embrittled that such wrapping resulted in cracks shown in the figure. The same effect also was observed to occur with this material after several months storage at ordinary room temperatures. Such failures probably can be ascribed to a combination of physical and chemical effects (20). With the 0.96-density polyethylene examined in Figure 5, the former seem to predominate since failure occurs in samples adequately protected with anti-oxidant, and

in nitrogen as well as in air. Furthermore, the effect in this material is found to be largely reversible on remelting the sample. This phenomenon, currently called thermal stress-cracking, has begun to receive serious attention in the literature (21, 22).

Certain of these same materials display another characteristic, quite possibly related to the thermal stress-cracking. German sources report service failures of cold-water pipe made from some of the newer, more rigid polyethylenes. These have been analyzed in a paper by Richard (23). Although the failures reportedly were caused by a creep mechanism, nevertheless they were described as brittle rather than ductile failures, resembling both environmental and thermal stress-crack failures. It is demonstrated easily that water aggravates a condition closely akin to stress-cracking in certain of the higher density olefin polymers. Racks of bent specimens prepared for the environmental crack test from such a polymer may develop cracks within one week's time if placed dry into a 70° C. air oven. If immersed in distilled water at the same temperature, they shatter within a few hours.

It is encouraging that not all high-density olefin polymers appear to be equally sensitive to this type of failure, just as not all of them show equal susceptibilty to thermal stress-cracking of the sort described above. What constitutes the controlling difference or differences between polymers which crack and those which do not crack is not at all clear. Molecular weight distribution is thought to contribute, and variables, associated with crystallite size and/or spherulite size associated with cracking phenomena might be expected to have bearing.

Except for the phenomena just discussed, the new olefin polymers appear to offer promise for the outer coating of submarine cable. Selected P.V.C. compounds characterized by very low water-extractability similarly are attractive, particularly some of the internally-plasticized semi-rigid compositions now making their appearance. Less heralded but of great possible importance to submarine cable, are new super crack-resistant polyethylenes made by the older high-pressure process. Some of these appear to have environmental stress-crack resistance at least equal to the present butyl rubber-modified compound. Such materials could find application as either the dielectric, the sheath, or both in future cable designs.

Little is known about the behaviors of any of these materials with actual long-time exposure directly in the marine environment. The possibility exists of attack from at least three sources (living animals, shipworms, burrowing clams, etc.), not including human mischief, which could inflict direct mechanical damage. There are the fungi, the bacteria, and other organisms that could consume the material for sustenance. Lastly, there is the possibility of chemical damage from excretions and other by-products of either of the former groups. Experience thus far can be summed up with the statement that no evidence of borer or bacterial attack of any consequence has been observed as yet, in any of the hydrocarbon or vinyl chloride polymers exposed in marine tests.

Acknowledgment

The author is happy to acknowledge helpful discussions with and contributions from K. G. Coutlee, G. H. Hunt, V. L. Lanza, and V. T. Wallder.

(Continued on page 68)

Wohlleben Replaces Csaszar on PT Editorial Advisory Board

Owing to the pressure of his work with his company, Ernest J. Csaszar, Sales Manager for Newark Die Hobbing & Casting Co., Newark, N. J., has been forced to resign from our Editorial Advisory Board. He had served on the Board as our authority on Moldmaking and Tooling since the magazine's inception in February 1955. At Ernie's recommendation, he is being replaced in our ranks by Max G. Wohlleben, Director of Sales and Engineering for Newark Die Co., Newark, N. J., effective May 1, 1959.

Max Wohlleben was born in Germany in 1903. He was educated in Germany, receiving his degree in Mechanical Engineering in 1926 from the Stuttgart-Esslingen Engineering College. From 1926 to 1927, he was Assistant to Chief Engineer in the Mercedes plant in Germany. He then served as Draftsman for Eisler Engineering Co., in Newark, from 1927-1928. This was followed by a position as Designer for Union Carbide's Oxweld-Acetylene Division from 1929-1931, and as Tool Designer for J. E. Mergott Co. He joined Newark Die Co. in 1935, was a Moldmaker for seven years, and spent 12 years as Chief Designer. In his present position, he is in charge of sales, engineering, and estimating. He is a member of SPE, and is interested in chess. Mr. & Mrs. Wohlleben have one son, and make their home in Union, N. J. —THE END

Edited by:
HARRY T. DOUGLAS
Executive Vice President
Lunn Laminates, Inc.
Huntington Station, N. Y.

Reinforced Plastics Is Hand Lay-Up Outdated?

VISITORS to our plant are sometimes surprised to see so much of our reinforced plastics operation devoted to hand lay-up and vacuum bag molding. They express the opinion that with so much being said about the virtues of press molding parts, why should we continue to dabble in this prehistoric method, long abandoned by other fiberglass fabricators? And what, if any, real significance could be produced by hand lay-up techniques?

If we were to open our books (or for that matter, those of any other custom molder!), they would be surprised to see how profitable this seemingly antiquated procedure is. However, I manage to restrain myself from proving my point in this enthusiastic manner, and instead point to the many components large and small that are essential products for many industries, as well as for government agencies.

When an order calls for a limited quantity of parts, it would be prohibitive in cost to produce these with expensive matched-metal dies. The tooling up for such a process also runs into considerable time. The capital outlay in both time and equipment should be made only if a guaranteed large-quantity order exists.

Some of the "graduates" of the hand lay-up method are superstructures and other fiberglass components for submarines, such as the Nautilus, Grampus, Halfbeak, and Skate; ducts and housings for aircraft; Nike radomes (which we still make); large antenna housings for communications systems; chemical tanks; Bell Boy pleasure craft; line handling boats; whale boats; 36-foot landing craft; and numerous other large- and small-sized products.

These items all were produced by the hand lay-up method utilizing either vacuum bag molding or contact molding, whichever technique was applicable in each case. All of the products mentioned were made in limited quantities which ruled out matched-metal dies. A limited number of units certainly does not indicate that the job is less important because only a few, or perhaps just one part, were ordered. For example, the sonar dome on the Nautilus is a one-of-a-kind project, and the important function of this hand "laid-up" part is evident. Therefore, one should not judge the value of hand lay-up pieces by the number of parts produced.

Those in the industry using hand lay-up processes have little "tooling" as such, and can get into production almost immediately. There is no waiting for the designing and finishing of precision dies. Production proceeds from pattern to prototype in a matter of days.

Undoubtedly, there are numerous fiberglass fabricators throughout the country using hand lay-up methods much like our own who are too occupied in their busy plants to look up and become aware of any criticism or condescending views expressed about this "crude" process. What we are doing at Lunn is being duplicated many times elsewhere with apparent success because of the continuing of this old method.

Improvements have been made in many directions in the reinforced-plastics molding field, including the introduction of new resins and new fabrics for laminating, but basically the hand lay-up method is unchanged. There is need for improvements here, also, but these are difficult to devise when much depends on manual labor. For example, the tedious squeezing out of excess resin and air with a hand blade before the vacuum suction takes over. In many cases, the resin puddles in contours and corners where the action of the vacuum pump sometimes cannot reach very effectively, and the only way to clear this is to squeeze it out by hand. On large curved components, some 20 feet or more in length, this task is a nuisance and necessitates someone crawling into the curvature to do a thorough job.

By far and large, the homely hand lay-up method is still going strong and is holding ground against the automation age because in custom molding, "hand tailoring" cannot be replaced by a machine.—THE END

Edited by:
PAUL E. FINA, *Dir. of Sales Engrng.*
The Fiberite Corp.
Winona, Minn.

Compression & Transfer Molding

Epoxy Molding Compounds—New Fields for Molders!

THE year 1959 will be remembered in the plastics industry for the introduction of several new commercial plastic molding compounds. These compounds will not be new to the ear, but will be made commercially avaliable for the first time. One promised boon to the thermoset molder is the advent of epoxy molding compounds. Why are these compounds of such importance? First of all, because they are a major contribution to the conventional thermoset molder who is the back-bone of the thermosetting field. Secondly, epoxy molding compounds will closely approximate the phenolics in molding techniques, with certain exceptions to be mentioned later. Thirdly, epoxy molding compounds generally are considered inert in comparison to other plastics. A revealing remark made by a molding engineer was, "Why, these compounds should be as stable as a rock!"

Epoxy molding compounds essentially will not compete with phenolics, but open up new fields for the molders. Here is what they offer:

(1). Incomparable dimensional stability under all conditions—this means the holding of exceptional tolerances! To date, only phenolic-glass has claimed this property. But under certain adverse conditions (such as continuous heat), phenolic-glass shrinks as do all other glass compounds. This property of dimensional stability is worth checking.

(2). Molding pressures as low as 50 psi! This means molding around very delicate inserts, coil forms, or tiny, slender pins without distortion and, of course, the use of lower-cost molds. Encapsulation by molding now is an actuality. A molder can reduce cost substantially over the potting compound methods. It should be possible to flash mold around metal parts for molded coatings. This, too, bears investigation.

(3). Retention of electrical properties under rigorous conditions. What molder has not gone through testing programs of an electrical part with reduction of properties under continuous heat, continuous steam or moisture, continuous outdoor exposure, etc.? Epoxies should pass with flying colors.

(4). Retention of mechanical properties. Many of the present plastic materials degrade when subjected to repeated thermal, chemical, aqueous, and outdoor conditions. The "rock-like" quality of the molded epoxies should overcome these problems.

(5). Exceptional resistance to strong alkalis. The textile industry, the washing machine industry, the chemical industry, etc., should become acquainted with this property.

(6). Retention of physical properties after long periods of exposure at 500° F.

On inquiring into the reason for epoxies' exceptional merits, the best and simplest explanation found is as follows: epoxy molding compounds cure in such a manner that there is a complete reaction of all molecules, with no by-products involved or given off. Epoxies have low viscosity during flow. The resin itself is remarkably resistant to degradation. The fillers employed do the rest.

What do the above characteristics mean to the molder in design techniques? As to mold design, no overflow vents should be necessary. Metal-to-metal die surfaces should be close fit and smooth (air escape may be needed).

Due to the extremely low pressure-to-mold requirements, lower cost molds are a possibility. Pin breakage problems are nil. As to piece-part design, it should be easy to mold-in tiny pin holes, printed circuitry, encap-

(Continued on page 69)

HERCULES

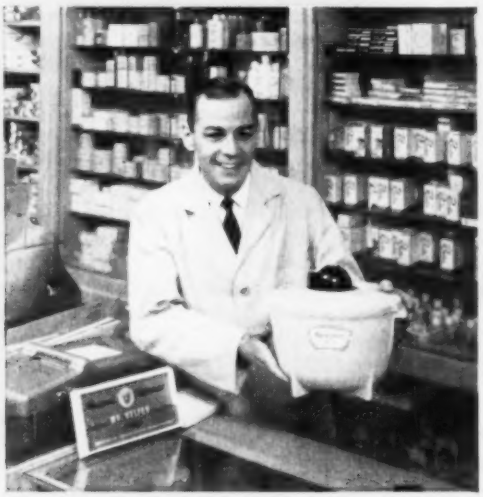
Plastics Hi-lites

Designers put the heat on thermoplastics

Greater temperature and chemical resistance of newer materials proves a big factor in their growing use

Designers are putting thermoplastics to work today in jobs where no one would have dreamed of using them a few years ago. In many instances, the better resistance to heat and chemicals provided by the newer materials has made it possible to design better looking, more functional products, at lower unit costs. Savings may lie in a number of different directions: cheaper processing, lower material costs, reduced shipping and handling charges, less breakage, or longer shelf life. But above all, it's the styling possibilities of the new plastics that most intrigue the designer, and are stimulating him in the conception of new plastics products, many for markets previously the exclusive domain of other materials. Here are some exciting results of this new trend in design.

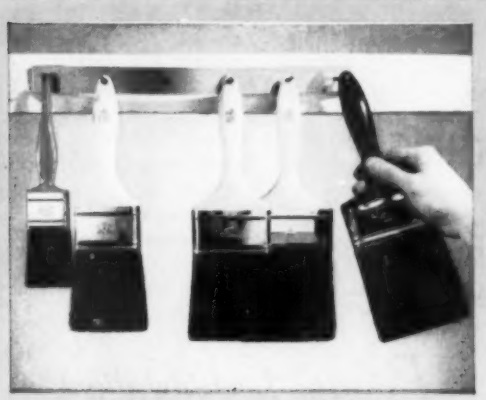
STYLISH AND SANITARY . . . A new all-plastic carafe and tumbler set provides a timely answer to the unfavorable publicity about unhygienic bedside hospital water. Manufactured by Zylon Products Company of Pawtucket, R.I., the set consists of a wide-mouth carafe with removable lid, a disposable plastic liner, and a matching tumbler. Carafe, lid, and tumbler are all made with Pro-fax®, Hercules polypropylene, and the plastic's high heat resistance makes it possible to autoclave the entire unit at the termination of a patient's stay. Daily replacement of the low-cost disposable carafe liner insures a clean water supply at all times without daily carafe sanitizing.



BETTER LOOKING AND SAFER, TOO . . . This new Prak-T-Kal vaporizer-humidifier is virtually unbreakable, easy and safe to handle and store. Molded with Pro-fax, the colorful, handsomely styled bowl and lid of this new unit cannot rust, discolor or corrode—advantages provided by this new polypropylene plastic. An automatic shut-off that cuts the current to the heating element before water is completely used, makes it safe to leave this unit unattended even in a child's room. Bowl and lid for the unit are molded by Jamison Plastics, North Bellmore, Long Island, N.Y., and manufactured and distributed by Practical Electric Products Corp., Long Island City, N.Y.

Pro-fax gives wood the brush-off

Pro-fax replaces wood in this new line of TUFLITE paint brush handles, providing a superior product at lower material and production costs.



Pro-fax gives TUFLITE handles in the popular Beavertail style all the merchandising features important in the fast-growing "do-it-yourself" market.

TUFLITE handles are lighter and more durable than wooden models, have a finish that is impervious to solvents, and will not crack, chip, peel, or wear off. Available in a rich array of handsome colors, they are the first plastic brush handles offering colorful styling in a low-cost product.

Not only lower in original cost, TUFLITE handles also cut the cost of brushmaking. Unaffected by humidity changes, they speed handle assembly, eliminating rejects due to shrinkage or swelling.

TUFLITE paint brush handles manufactured by H. V. Hardman Co., Inc., Belleville, New Jersey.

Hi-Fax® serves soap in style

A handsome globe molded with Hi-fax, Hercules high-density polyethylene, makes Bobrick's new line of soap dispensers an attractive asset to any washroom. Much safer, too, since the globe won't crack or shatter if dropped when being refilled. They have a soft lustrous snow-white finish that's easily kept like new by simple damp-cloth cleaning. Bobrick selected Hi-fax after testing other materials for durability and resistance to chemicals. Globes are blow-molded by Olympic Plastics, Inc.

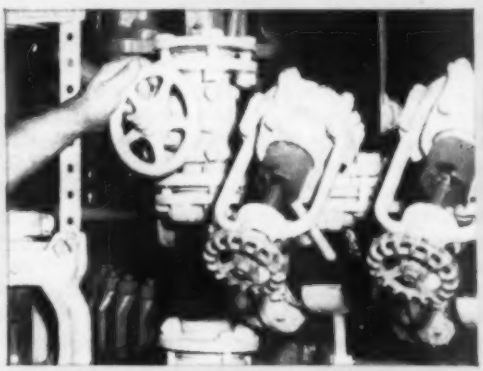
Design Hi-lites

From a designer's standpoint, a new spectacle case molded by Parmalee Plastics for U. S. Safety Supply Company is one of the most exciting uses of Pro-fax seen to date. The cover, hinge, case, and latch are all one piece of Pro-fax molded in a single shot, in a cleverly designed mold. A true plastics paradox, the case and cover depend on the *rigidity* of Pro-fax in achieving a durable, protective package for a delicate product, while at the same time the molded hinge relies on the *flexibility* of Pro-fax in thin-wall sections. If that weren't enough, the resilience of Pro-fax makes possible a strong, snug-fitting latch, which nonetheless releases readily under delicate thumb pressure.

Using the same basic idea, a variety of other such Pro-fax packages suggest themselves for products like cosmetics, tools, toys, or personal goods.

40 months' resistance to corrosive acids

Here's a "proved-in-action" case history of Penton®, Hercules chlorinated polyether — the new thermoplastic polymer with exceptional resistance to corrosion at elevated temperatures. The valve at left in this photograph is a Hills-McCanna diaphragm valve with a cast iron body lined with Penton. It is continuously exposed to carbon



tetrachloride, hydrochloric acid, and wet chlorine at temperatures up to 85°C. The valve has operated in this highly corrosive system since September 29, 1955 without a single failure in over forty months. Indicative of the corrosive atmosphere is the use of Haveg, glassed steel, porcelain and Pyrex for other valves and piping in this system. To learn more about Penton in valves, pipe and fittings, pumps and meters, flame-sprayed or whirl-sintered parts, write to Hercules for your copy of "The ABC's of Penton for Corrosion Resistance", and the technical brochure on Penton's properties and uses.

HERCULES POWDER COMPANY
INCORPORATED
900 Market Street, Wilmington 99, Delaware

HERCULES

THREE NEW MATERIALS FOR THE PLASTIC INDUSTRY

HI-FAX® HIGH-DENSITY POLYETHYLENE • PRO-FAX® POLYPROPYLENE • PENTON® CHLORINATED POLYETHER

PLASTICS TECHNOLOGY

EXPLORING FABRICATION TECHNIQUES

By L. J. ZUKOR, *Engineering Editor*

Injection Molding . . .

. . . of housewares and construction materials is now a highly competitive manufacturing and marketing operation. Molders who wish to retain and increase their profits should examine and upgrade their operations periodically. A good way to accomplish this is to set up a comprehensive operational check list. This list can also serve as the basis for a company's cost accounting analysis. A recommended check list which is easily modified to suit any type of molding operation from the largest to the smallest is shown in the accompanying chart.

The scope of this article precludes an examination of each item, and does not attempt an analysis. It will, however, point up a method of approach that can be used with such a list. With this in mind, let's take the first item and look for areas and means to lower material costs. To accomplish this we could polymerize our own material. But if this seems too involved, we might try a simpler approach. Here is what one molder did quite successfully. He found that his shipping costs included the empty return trips of his trucks, so he had his truckmen pick up material at the nearest F.O.B. depot on their return trip. In this way, a cost that he was already saddled with was made to pay off and his material costs were reduced because the return trip was made with a pay-load.

In the number two slot is warehousing. Many plants charge this space off at the same rate as operating space. Also, in a busy plant material storage usually starts encroaching on other operations. Some molders, who have enclosed yard space, set up lean-to or shed structures for storing raw materials. Others use tarpaulin storage with the new weatherproof polyethylene bags supplied by some material producers. It is important to note that in warehousing, savings can only be made in stack height and floor space costs. These should never be as costly as operating floor space.

Again, space in the column does not allow for elaboration on equipment costs. Information for equipment planning is contained in a still very timely article presented by Mr. Gordon B. Thayer in our May 1958 issue. His current article on Auxiliary Equipment appears in another section of this issue.

Certain basic considerations depend on the length of a production run. For example, it determines whether or not to use hot-runner molds or multiple nozzles to eliminate the sprue. The length of run also determines whether or not complete automation of the injection machine is required. Shorter cycle time is accomplished by preheating or preplasticizing equipment. Since profit lies in operating efficiency, another way to arrive at lowered operating costs is to replace obsolete equipment with modern high-speed machines. A further check of worn equipment and machine services will usually show where additional savings are possible by replacement and/or modernization of such equipment.

Plant lay-out is a classification that can be included in the equipment-cost category. A plant which "growed like Topsy" is never as efficient as one that is set up by planned lay-out—in which traffic lanes are clearly defined. At this point, quality control is certainly worth mentioning and defining. Essentially, it is a method of continuous sampling and inspection maintained on a statistical basis and covering all phases and conditions of manufacture. A check of product

Primary Considerations

1. RAW MATERIAL COSTS
2. IN-PLANT MATERIAL COSTS
   a. INVENTORY WAREHOUSING
   b. CONVEYING AND HANDLING (INCLUDING COLORING)
3. EQUIPMENT COSTS (OBSOLESCENCE)
4. PRODUCT HANDLING COSTS
   a. CONVEYING AND TRAFFIC
   b. INSPECTION AND PACKAGING
   c. INVENTORY STORAGE
   d. SHIPPING

Secondary Considerations

1. JIG AND FIXTURE SHOP COSTS
   a. MOLD PREPARATION
   b. MOLD PURCHASE AND INVENTORY
   c. STORAGE

quality at a machine, not after an entire lot is run, pays dividends in lower reject rates and less scrap. Scored and frayed dies can be pulled before they become irreparably damaged. Quality control begins with raw materials and ends with the packaged product.

Many innovations have been tried, but it is the exception rather than the rule that most molders operate with a methodical list which covers all phases of their operations. Usually only the trouble spots get the attention thereby overshadowing others that also need attention. *Do not overlook any phase of operation lest hidden losses cheat you of your profits.*

The best engineering formula yet devised is:

Improved operations = Savings = Profits.

●

Compact Water-Refrigeration Units . . .

. . . are being employed more and more frequently, to solve difficult and expensive water disposal problems arising from the cooling of injection and other plastic forming machines, and for trough cooling of extruded products. Water chillers, fitted with recirculating units and filters in a closed system, require only a small amount of "make-up" water after the initial filling. Complete discharge of this system is generally not required when a substantial sump-reservoir is used. Thus, it is possible to empty individual pieces of equipment for periodic maintenance or repair without discharging the coolant to sewage. A recirculating system is justified when water and sewage-disposal costs are high; also, when the ambient water supply temperature varies greatly from season to season or is higher than the temperature required for cooling.

Several good units are available to the molder, and choice will depend on his individual requirements. A unit is sized mainly by two things; the temperature differential between inlet and outlet, and the flow quantity. Sizing and heat-transfer calculations are normally supplied as a service by the manufacturer.

Some typical case histories are presented as examples of what can be accomplished by the use of chiller units.

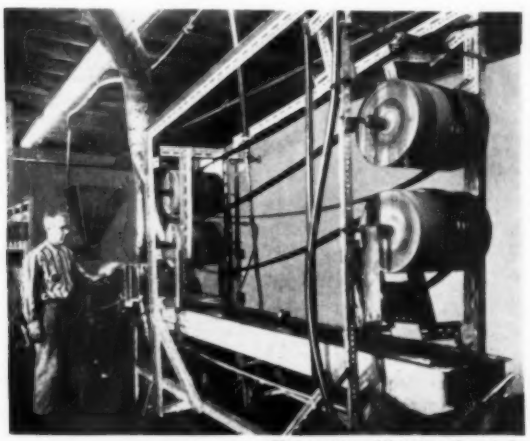
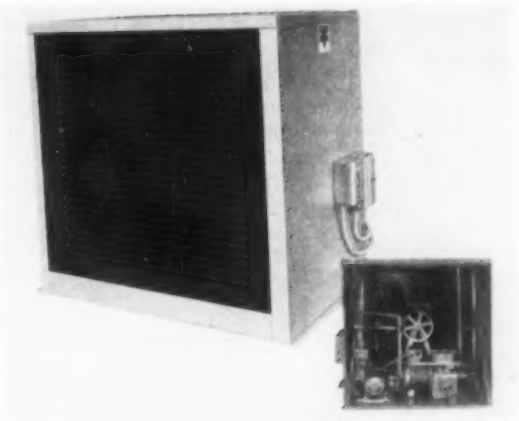


Photo courtesy of Rosenberg Bros. & Co.

Typical extrusion cooling trough.



Front and back view of VIC chiller.

Of the many companies using water cooling equipment, Rosenberg Brothers and Co. have had repeated success with their installations which were supplied by the Vic Manufacturing Co., of Minneapolis, Minn. Rosenberg Brothers and Co., located in Smithtown, L. I., New York, are manufacturers of garden hose, tool handles, and other extruded products. They are also suppliers of cellulose acetate molding powders. Their extensive extruding operations required large quantities of cooling water. However, in their present location, the only available sewage disposal means was through cesspools. In a two-year period, the firm had installed three cesspools which were unable to reduce the disposal load substantially. A study was made, and the problem solved through installation of the recirculating chiller. This reduced the load on the cesspools. In addition it enabled the firm to increase production by reducing the cooling cycle on the machines.

Another company, Gilbert Plastics, Kenilworth, N. J., are custom and and proprietary injection molders of food packaging, aerosol can caps, and utility boxes. This firm obtains its water from its own artesian well. The temperature of the water as drawn from the well is 55° F.

In a review of its operations, the company found that cycle time on thin-sectioned molded parts could be decreased appreciably by faster cooling. This could be accomplished either by increasing the cooling area in the mold or decreasing the temperature of the coolant. They chose to lower the temperature, which is now established at about 35° F. Since 1952, they have increased their cooling capacity to a point where they now realize a 32% increase in the number of molding cycles, a 15% reduction in rejects, and an over-all production increase of 100%.

For the initial installation, and subsequent enlargement of facilities, Gilbert Plastic were supplied with chillers manufactured by Mayer Refrigerating Engineers, Inc., Lincoln Park, N. J.

Other molders have reported equal successes in lowered production costs with units supplied by Injection Molders Supply Co., of Cleveland, Ohio.

—THE END

Embrittlement of Polyethylenes

(Cont'd. from page 37)

A definite correlation between melt index (or molecular weight) and heat embrittlement was found. Injection-molded specimens, 1.5 x 0.5 x 0.07-inch in size, were prepared from several different melt-index resins ranging from 0.7-20 with the same density and made by the same process. These samples then were conditioned at 230° F. and checked for embrittlement. The resulting data are shown in Figure 3. It can be seen that the time to reach brittle fracture increased from 48 to 96 hours as the melt index was lowered from 20 to 0.8.

This dependence of melt index on heat embrittlement actually was confirmed in a molder's shop. Here, a melt index 4, 0.935 density resin was being tried in molding a part which would be subjected to temperatures of about 180° F. in intermittent service. In actual end-use testing, the part embrittled after 96 hours of continued exposure at 180° F. Switching to a melt index 1 resin of the same density yielded a part which still was satisfactory after 375 hours.

Processing Conditions

After considering the above factors, it seemed desirable to determine the effect of processing conditions on the susceptibility to heat embrittlement. Samples of 0.95-density polyethylene, 1.5 x 0.5 x 0.125-inch in size, were die-cut from injection molded tensile bars and checked for embrittlement at 200° F., as before. The results, summarized in Table 3, point out that the higher stock temperatures result in appreciable improvements in resistance to heat embrittlement, probably as the result of less molding strain in the parts.

Conclusions

The term "heat embrittlement" has been defined as the loss of mechanical properties after exposure to an elevated temperature below the crystalline melting point. This phenomenon was seen to be the result of a temporary increase in crystallinity as measured by polymer density; in addition to, or combined with, polymer degradation by oxidation.

Antioxidants have not been shown to improve resistance to heat embrittlement, although their use may be indicated. No definite correlation was found between polymer density and susceptibility to heat embrittlement. A definite correlation existed between heat embrittlement and melt index, with the lower melt-index resins being best. In an injection molding operation, higher stock temperature gave better resistance to heat embrittlement than did lower stock temperatures.

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(Cont'd. from page 61)

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—THE END

Technical Services— Responsibilities of Resin Supplier

(Cont'd. from page 56)

(4). Prepare and present technical reports and speeches.

(5). Approve customer items for labeling.

(6). Serve as liaison between salesmen and research and/or production.

—THE END

(Cont'd. from page 63)

sulation, and delicate inserts (ceramic, other thermosetting materials, thin-walled stampings, wiring, etc.). Molding techniques approximate the phenolics, with the exception of molding pressure. Some comparable properties are listed in Table 1.

Epoxy materials lend themselves to a wide range of colors with much improved color stability over phenolics under room temperature and ultra-violet light conditions. Presently being investigated is the latitude of colorability and retention of color brightness at temperatures up to 500° F. It has been found that the heat resistance of these epoxy materials is much improved over the best currently-available general-purpose, heat-resistant phenolics, as shown by the following test results. These show a relative comparison with a heat-resistant, general-purpose phenolic and mineral-filled, general-purpose epoxy specimen subjected to 500° F. for a period of seven days. The results are as follows:

Property	Mineral-filled Epoxy	Heat resistant Phenolic*
Weight Loss, %	3.4	26.3
Change in Length of bar, %	—1.3	—4.5
Flexural strength @ 23° C. after heating aging, psi.	10,200	1,100
Retention of strength, %	75	11

*Note: Phenolics had shown the best heat resistance of all plastics except silicones.

These values leave no reason to doubt the better retention of mechanical properties at elevated temperatures.

In general, these first epoxy molding compounds have the following attributes: extremely low pressure required to mold; retention of properties under adverse conditions, especially humidity; unparalleled dimensional stability; no gassiness; inertness; arc resistance up to 185 seconds; water absorption as low as 0.10%; resistance to alkalis; and heat resistance to 500° F.

In addition to the present grades, low-impact types will be developed with higher impact strengths through the use of stronger reinforcing fillers. Reinforcing fillers of the glass fiber, matte, and cloth type have been in use with epoxy lay-ups for quite some time. Epoxy molding compounds had been difficult to release from the mold, but the new compounds release very readily.

In conclusion, it might be well to review the general nature of the resin already in use. Early epoxy plastics were based on resins that were the reaction product of bisphenol A and epichlorhydrin. Lately, many new approaches to synthesizing epoxies have led to improved resins for formulating molding compounds.

Table 1. Comparative Properties of General-Purpose Thermoset Materials.*

	Mineral Epoxy	Asbestos Melamine	Alkyd	Alkyd	Diallyl Phthlate	Phenolic	Silicone
Flexural strength, psi.	11,500	7,500	7,000	6,000	7,500	8,500	6,500
Flexural modulus of elasticity, $x10^6$ psi.	2.2	1.8	2.1	1.9	1.2	2.0	1.0
Work-to-break, ft.-lbs.	0.144	0.073	0.062	0.049	0.12	0.16	0.11
Max. deflection, mils	57	45	35	35	70	65	70
Izod impact strength, ft.-lbs./in. of notch.	0.35	0.31	0.32	0.35	0.29	0.25	0.32
Heat distortion point, °C.	110	130	165	165	—	150	250
Measured at 23° C.:							
Volume resistivity, megohm/cm.	$9x10^9$	$3x10^7$	$3x10^7$	$3x10^7$	$3x10^7$	$3x10^7$	$3x10^7$
Power factor at 60 cps.	0.011	0.064	0.040	0.035	0.043	0.024	0.0045
at 1 KC.	0.019	0.037	0.023	0.025	0.044	0.023	0.0044
at 1 MC.	0.013	0.030	0.015	0.013	0.048	0.012	0.0065
Dielectric constant at 60 cps.	4.4	7.2	6.2	5.8	6.2	5.2	4.8
at 1 KC.	4.2	6.7	5.7	5.4	5.7	4.8	4.8
at 1 MC.	4.1	5.7	5.3	4.9	4.6	4.3	4.6
Arc Resistance, secs.	180	180	180	185	140	80	300
Measured at 100° C.:							
Volume resistivity, megohm/cm.	$5x10^7$	$6x10^6$	$3x10^7$	$6x10^6$	$3x10^7$	$1x10^5$	$3x10^7$
Power factor at 60 cps.	0.032	Too High To Measure	0.080	0.110	0.103	0.32	0.011
at 1 KC.	0.028	0.234	0.065	0.071	0.072	0.089	0.0080
at 1 MC.	0.016	0.047	0.026	0.027	0.096	0.027	0.0080
Dielectric constant at 60 cps.	4.9	Too High To Measure	7.8	7.4	7.6	7.0	5.0
at 1 KC.	4.6	9.4	6.9	6.3	6.5	5.5	5.0
at 1 MC.	4.3	6.3	5.7	5.3	6.4	4.6	4.8
Measured at 200 C.:							
Volume resistivity, megohm/cm.	$5x10^1$	$3x10^3$	$3x10^1$	$6x10^3$	$9x10^1$	$9x10^2$	$5x10^5$
Power factor at 60 cps.	0.35	Too High To Measure					0.042
at 1 KC.	0.084	0.384	0.158	0.286	0.248	0.66	0.021
at 1 MC.	0.019	0.043	0.044	0.035	0.176	0.198	0.010
Dielectric constant at 60 cps.	5.9	Too High To Measure	13.4	Too High To Measure	0.13	Too High To Measure	4.9
at 1 KC.	5.1	8.2	9.2	7.6	8.9	66.8	4.8
at 1 MC.	4.3	5.1	7.1	5.3	9.2	6.4	4.5

* Contain no reinforcing fillers.

—THE END

NEWS of the Industry

company moves and expansions

Eastman Chemical Products, Inc., announced that its manufacturing associate, **Texas Eastman Co.,** was expanding the polyethylene capacity of its Longview, Tex., plant from 85-million to 100-million pounds annually. It was also revealed that the OXO facilities at Longview were increased to bring aldehyde capacity to 125-million pounds per year.

Northern Plastics Corp. has successfully completed its first public financing program, the initial step in an over-all expansion program. Previously, all stock was held by company officers. Net proceeds amounted to $180,000, which will provide working capital for expanding Norplex laminated plastics production. Plant facilities will be enlarged, and a national sales organization is being established. Other Northern products include printed circuits, turned out by its subsidiary, **Norplex Fabricators, Inc.**

Seiberling Rubber Co.'s plastics division has outgrown its plant in Newcomerstown, O. A plant addition of 20,000 square feet will be added to provide added production space, laboratories, and offices. Completion is scheduled for this spring, and the goal is to double the division's production and sales within the next three years.

Peerless Plastics Co. has installed $100,000 worth of new machinery, marking the first step in a projected $250,000 expansion program. The Culver City, Calif., firm thus increases its custom molding capacity by more than 50%. New equipment includes a 2½-ounce Van Dorn injection molding machine, a 12/16-ounce Reed Prentice, a 20/28-ounce, HPM, and a 150-ton transfer compression press.

National Vulcanized Fibre Co. has acquired **Parsons Paper Co.,** Holyoke, Mass. Under the transaction, 76,000 shares of National's common stock was exchanged for the assets of Parsons. The company will be known as the Parsons Paper division.

Union Carbide Corp.'s capacity for producing low-density (conventional) polyethylene should reach 410-million pounds per year sometime this summer, according to Howard S. Bunn, president. This represents a considerable increase over the current 330-million pounds. He also stated that technological and engineering advances will permit incremental expansion of existing facilities by almost 40% with a relatively small new investment.

J. O. Ross Engineering Division, Midland-Ross Corp., has moved its Chicago offices to 370 South School St., Mt. Prospect, Ill. The **Hartig Extruder** division and **John Waldron Corp.,** another Midland-Ross subsidiary, also have moved into the larger quarters.

changes in ownership, new companies

Expandex Corp. is the name of a new plastics processing firm, to be located in Wauregan Mills, Conn. According to company president, Hugh R. Graham, Expandex will foam, extrude, and mold polystyrene for custom applications. Over 16,000 square feet of production space have been leased, and machinery should be installed shortly. Initial employment will be 20; however, this figure should increase to 60-70 within six months. Mr. Graham has been connected with the plastics industry for a number of years, most recently as superintendent of a Massachusetts plant.

Witco Chemical Co., Inc., has announced the merger of **Emulsol Chemical Corp.,** Chicago, Ill., with a Witco subsidiary—the organic chemicals division. Expressed aim is to widen Emulsol distribution through the parent firm's sales force. Emulsol salesmen will be absorbed in the Witco organization. The merger also will result in a 50% expansion of Emulsol research facilities, and additional construction is underway.

Riverside Plastics Corp., Hicksville, N. Y., has purchased the **Bischoff Chemical Corp.** from **Miles Laboratories.** The move enables Riverside to acquire specialized facilities for producing new resins for high-temperature applications. Riverside also will continue to manufacture and market the Bischoff line of Thermo-Cote protective strippable coatings.

offers conversion service

Hull-Standard Corp. offers to convert existing semi-automatic compression molding presses to fully-automatic. Conversions are currently available for practically all Hull-Standard and Stokes-Standard presses.

discontinues cymac production

American Cyanamid Co. has decided to discontinue the manufacture and sale of methylstyrene-based Cymac molding compounds. Official closing-out date is June 1.

Four parts of **TENITE BUTYRATE** form this tough, lightweight nozzle

Here's a good example of how a switch to Butyrate plastic can mean an improved product, with savings in both material and manufacturing costs.

Four parts of transparent green Tenite Butyrate make up this product. Assembled in an adjustable, leakproof fit, they form an attractive and durable hose nozzle which sells at a popular price.

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Remember this use of Butyrate whenever you need a tough, outdoor plastic, readily adaptable to design. Tenite Butyrate is available in a wide range of flows and colors for injection molding or continuous extrusion. Look into the design and economy possibilities offered by this versatile plastic. For more information on Tenite Butyrate or any other Eastman plastic, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

Trans-Flo hose nozzle molded of Tenite Butyrate by The Vichek Tool Company, Cleveland 4, Ohio.

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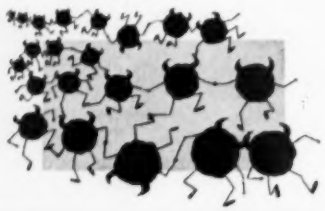

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News of Industry *(Cont'd.)*

new plants and laboratories

Carl H. Biggs Co., Inc., manufacturer of epoxy adhesives, moved for the third time in nine years—to a new 12,000-square foot building at 1547 14th St., Santa Monica, Calif. The move was necessitated, according to company sources, since the firm's sales have doubled every year for the last seven.

Gulf Oil Corp. plans to construct a multi-million dollar Oxo alcohols plant at its Philadelphia refinery. Intended primarily for the production of isooctyl and decyl alcohols, it will also be utilized for the manufacture of other Oxo petrochemical products. Engineering work on the plant has been completed, and construction is scheduled to begin this summer. Operations should commence in the summer of 1960. The two materials mentioned are used extensively in the manufacture of PVC plasticizers.

American Viscose Corp.'s film division has opened a new distribution center for Avisco cellophane at 8900 Chancellor Row, Brook Hollow, near Dallas, Tex. The new building will also house the district sales office. The new facilities should enable the firm to provide greatly improved service in the southwestern area. Up-to-date processing equipment has been installed for handling cut-to-size orders, and the center also is equipped to handle orders for the converter department.

NRC Equipment Corp. has opened a West Coast engineering office in Palo Alto, Calif. Manager for the operation is Edward G. Ferrari.

new material/product offerings

Spencer Chemical Co. has announced the availability of a polypropylene resin tradenamed Poly-Pro. Production is expected to reach 20-million pounds by 1960.

Cast Optics Corp. has announced the availability of Evr-Kleer 111 heat-resistant cast acrylic rods and blocks. Rods will be 0.5-2 inches in diameter, blocks from 6-24 inches thick in desired sizes.

price changes

Plax Corp. has reduced the price of its Polyflex biaxially-oriented polystyrene film and sheeting by approximately three cents per pound. The reduction applies to all gages from 0.001-0.002 inch.

Reichhold Chemicals, Inc., has announced price reductions on Polylite polyester resins by one cent across-the-board. Alkyd resins for surface castings and finishes were reduced by ¼-1 cent per pound.

Dow Chemical Co. has announced a new marketing plan for colored Styron (polystyrene) called "Volume Inventory Production." The colored material can be ordered, in volume, for a 1½-cent per pound differential over the base prices for crystal and natural materials.

Monsanto Chemical Co. has announced a four cent per pound reduction in the price of phthalic anhydride. This amounts to an almost 20% reduction, and brings the tank car price to 16½ cents per pound. Also reduced were phthalate ester plasticizers by 6-13% and dioctyl phthalate from 28 to 25 cents per pound.

dutch current-meter cable

Draka of Amsterdam, Netherlands, supplied the 700 meters of cable recently installed off Ymuiden to register the velocity of sea currents. The cable consisted of 24 copper wires insulated with polyethylene, spaces being filled out with a non-hygroscopic compound. Over this goes a double envelope of polyethylene and armor of galvanized steel wire. The outer sheathing is PVC, selected for its high abrasion resistance.

french polypropylene

Pechiney and **Societe Normande de Matieres Plastiques** reportedly will produce Moplen polypropylene under license from Montecatini. Initial output is estimated at 10,000 tons per year.

french welding machine

Societe de l'Electronique Francaise, in cooperation with **Saint-Gobain Co.,** has developed a remote control electronic machine for welding plastic bags for plutonium filters. Chief feature is that the welding clamp can be displaced in both vertical and horizontal directions; the latter automatically, with the clamp advancing after each weld by a distance equal to the electrode length. This insures a tight weld along the length of the bag. Once the clamp is adjusted to the required height, operation can be regulated by push buttons, or a wholly automatic cycle can be initiated. In the latter case, the clamp can move from left to right, or vice versa, depending upon the starting position. The clamp moves vertically 1,250 mm., and horizontal displacement permits a weld seam of 1,800 mm. The machine has a 1,200 watt generator, and frequencies are 27.12 megacycles. A surface of 25 cm. on two sheets 30-100 mm. thick can be welded in approximately one second.

Errata

A "Letter to the Editor" by J. B. Crenshaw, of Interchemical Corp., suggests some additions that could be made in the article, "Optical Properties of Translucent Glass-Reinforced Panels," by Daniel Smith and Mr. Crenshaw, that was published in our March issue, p. 42-9. Mr. Crenshaw also notes some corrections that should be made.

In addition, an error was made in Table 3 (Optical, Physical and Cure Properties Test Results) on page 46. The data given for "Liquid Resin Color" should be replaced by:

	Average	Standard Error	Significant Factor Contrasts A	B	C	D	E	F	G	H	J
Liquid resin color (C.I.Ex), 1 cm. cell	0.3142	±0.0001	—	—	—	—	—	—	-.0031	—	—
Unreinforced sheet color (C.I.Ex), 3 mm. thick	0.3140	±0.0002	—	—	.0005	—	-.0007#	.0024#	-.0014	.0006	—

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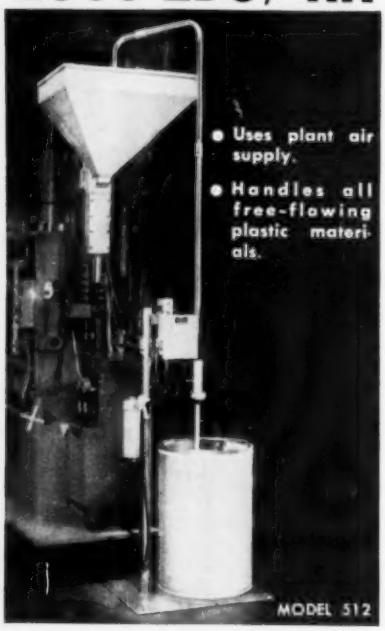

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News of the Societies

SPE Pittsburgh Section

SPE's Pittsburgh section will hold its first annual RETEC May 7th at the Penn-Sheraton Hotel, Pittsburgh, Pa. Entitled "Plastics in the Metal Industries," the program will consist of four sessions—two held concurrently in the morning, and two in the afternoon. J. H. DuBois, plastics consultant, will deliver the luncheon address, "Looking Ahead in Plastics." Pre-registration forms can be obtained from the committee chairman, John E. Parks, Hydraulic Press Mfg. Co., 512 Empire Bldg., Pittsburgh 22, Pa. Papers scheduled for delivery at this meeting include:

10:00-10:30 AM

"Teflon and Metals," R. B. Fehr, Jr., E. I. du Pont de Nemours & Co.

"Plastic Lined Tanks," W. P. Cathcart, Tank Lining Corp.

10:30-11:00 AM

"Penton, A Construction Material for Corrosive Applications," Clarence S. Miller, Hercules Powder Co.

"Maintenance Uses of Nylon in the Metal Working Industries," Robert Koch, Polymer Corp.

11:00-11:30 AM

"Lexan, A New Engineering Material," R. J. Thompson, General Electric Co.

"Aluminum-Foamed Panels," L. W. Hovland, Aluminum Co. of America, and Prof. E. R. McLaughlin, Pennsylvania State University.

11:30-12:00 AM

"High Density Polyethylene," O. E. Larsen, Phillips Chemical Co.

2:30-3:00 PM

"Nylon and Delrin Resin Applications in the Metals Field," R. N. Peterson, E. I. du Pont de Nemours & Co.

"Extending the Horizon for Steel Shipping Containers With the Use of Plastic," E. B. Edwards, Jones & Laughlin Steel Corp.

3:00-3:30 PM

"Polypropylene Fabricated Equipment," W. Paul Acton, Hercules Powder Co.

"High Density Protective Coatings," S. M. Hmiel, Koppers Co., Inc.

3:30-4:00 PM

"Plastics As Construction Materials in the Steel Industry," Joseph Bigos, United States Steel Corp.

SPE Edits Book on Foams

SPE's Plastics Activities Group on Plastics in Building, together with members of its subordinate committee at the Newark section, are reviewing an elementary text on foam plastics which will be used by ordnance design engineers.

The book was written by William Tanner, who is attached to the Plastics and Adhesives Research section at Picatinny Arsenal, N.J. Ronald J. Carney, PAG chairman, with Vincent Sussman of the Newark section are supervising the task of checking it for accuracy and completeness.

Vinyl-Metal Group Joins SPI

The Vinyl-Metal Laminators Institute, an organization of seven companies which laminate vinyl film and sheeting to metal, has joined the Society of the Plastics Industry, Inc., and will function as one of its divisions. The Institute has prepared a number of specifications for vinyl-metal laminates, and is considering further work on commercial standards in conjunction with the U. S. Department of Commerce.

SPE New York Section

More than 200 members and guests gathered April 15 at the Governor Clinton Hotel to attend the regular monthly meeting of SPE's New York section. Topics for the program included "Polypropylene" and "Epoxy Plasticizers for Vinyl Compounds."

A paper entitled, "Polypropylene, Properties, Methods of Fabrication, and Applications," was delivered by John Y. Lomax, Hercules Powder Co. Mr. Lomax discussed the unique properties of this olefin polymer, as well as its mechanical behaviour in about 20 molded and extruded items. The discussion was supplemented with slides which compared the physical properties of polypropylene with other resins.

The vinyl Professional Activities Committee was host to two speakers on epoxy plasticizers for vinyl compounds. This program was moderated by Irwin L. Podell, Irwin L. Podell, Inc., who outlined their purpose and use. These plasticizers fall into two types: soy bean epoxy; and ester type epoxy.

R. F. Conyne, Rohm & Haas Co., talked on "Plasticization of Polyvinyl Chloride With Oil Epoxides." Oil epoxide plasticizers contribute simultaneously to both plasticization and stabilization of PVC compounds. Although their contribution to heat stability is usually a linear function of oil epoxide concentration, their effects on light stability are less predictable. Oil epoxides enhance the durability of vinyls because of their resistance to volatility and extraction loss. Certain conditions cause a loss of compatibility with PVC compounds, but this pitfall can be avoided by careful formulation.

"Monomeric Epoxy Plasticizers—Their Contribution to the Vinyl Compound,"

was discussed by Joseph Fath, Thompson Chemical Co. Use of these materials is expected to grow rapidly due to a better definition of their place in vinyl compounds. At present, four epoxy fatty acid esters dominate the commercial market. Their performance properties were compared to provide a clearer understanding of the place for each. In estimating the quality of an epoxy plasticizer, undue stress has been placed on residual iodine number. It is suggested that oxirane efficiency be considered in combination with residual unsaturation. New evidence shows that monomeric epoxies are more compatible than had been assumed previously. Further, they show excellent low temperature performance, and yield low viscosity plastisols. In view of this, their re-examination for present and future applications is proposed.

SPI 16th Annual Conference

The SPI Pacific Coast Section's 16th Annual Conference, held March 25-27 at the Hotel Del Coronado, San Diego, Calif., featured 15 papers on material development, processing methods, and product applications. Papers presented and speakers include:

"Today's Approaches to PVC Stabilization." Robert A. Buckley, Ferro Chemical Corp.

"Polypropylene Markets." Robert D. Ullrich, Hercules Powder Co.

"Delrin, Acetal Resin." C. R. Lindegren, E. I. du Pont de Nemours & Co., Inc.

"Polyethylene Copolymers, Properties and Applications." David A. Jones, Celanese Corp. of America.

"Developments in Plastics Converting Equipment." Robert Moyer, Monsanto Chemical Co.

"Blow Molding Techniques." Soren Graae, Blow-O-Matic Corp.

"Molding of Anisotropic Plastics." Howard S. Malby, Celanese Corp. of America.

"Sequential Impact Molding." Fred C. Means, Fellows Gear Shaper Co.

"Approaches For Use of Plastic Glazing on High Speed Aircraft." Carey Carpenter, Swedlow Plastics Co.

"Magnetic Tapes For Sound and Video Systems and For Instrumentation." Harold Dague, American Recording Tape Co.

"Responsibilities of Raw Material Manufacturers in Market Development." Theodore W. Sharp, Union Carbide Plastics Co.

"Effects of Storable Rocket Propellants on Plastic and Elastomeric Materials." Robert C. Mowers, Rocketdyne Div., North American Aviation.

"Polystyrene in Lighting Applications." P. H. Estes, Dow Chemical Co.

"Applications for Plastic Film and Plastic Film Laminations." H. B. Pollack, E. I. du Pont de Nemours & Co., Inc.

"Building With Honeycomb Sandwich Construction." Andy Marshall, Hexcel Products, Inc.

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Names in the News

Herbert R. Herman

Herbert R. Herman has been appointed chief chemist for Fiberfil, Inc., and will head up all development activities. He previously served as research chemist for Pennsylvania Industrial Chemical Corp., chief chemist for Ball Chemical Co., and with the U. S. Chemical Warfare Service.

Donald J. Collins and **Richard I. Goodkind** have been elected vice presidents in charge of marketing and administration, respectively, for Tennessee Products & Chemical Corp. Mr. Collins previously served as general sales manager and Mr. Goodkind was administrative assistant to the firm's president.

John R. Stanley has been appointed sales manager for Borden Co.'s Resinite garden hose products. He formerly served as manager, service products department, for Lily Tulip Cup Corp. Area to be covered by Mr. Stanley includes an area from the Gulf of Mexico to the Canadian border and east of the Rockies.

John H. Scherer has been appointed general manager and **Edward C. M. Homan** director of research and product development at Sun Chemical Corp.'s electrotechnical division. Mr. Scherer formerly served as vice president, marketing, and director of sales for Thermoid Co. Prior to that, he spent 19 years with the Permacel Tape Corp., where he was vice president and member of the board of directors. Mr. Homan is the former vice president of Bonded Products, Inc., and had served as vice president and technical director of Electro-Technical Products before its merger with Sun.

William H. Chadbourne, vice president and general manager of Fiberfil, Inc., has been elected to the firm's board of directors. He joined the firm last October, having previously served as vice president in charge of sales for Danielson Mfg. Co.

Floyd F. Rechlin has been named structures research specialist for Narmco Industries' research & development division. Since 1941, he has been continually engaged in advance design activities at Convair, Rohr, and Solar Aircraft companies. Most recently Mr. Rechlin has been concerned with the development of brazed honeycomb sandwich materials.

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The following promotions have been announced by Union Carbide Chemicals Co.: **J. R. Howell** from assistant district manager, Chicago, to manager of the Albany district; **Russell W. Martin** from technical representative, Chicago, to assistant district manager; and **Carl D. Preston** from technical representative to assistant manager, New York district.

Robert F. Hrudka

Roy Carson

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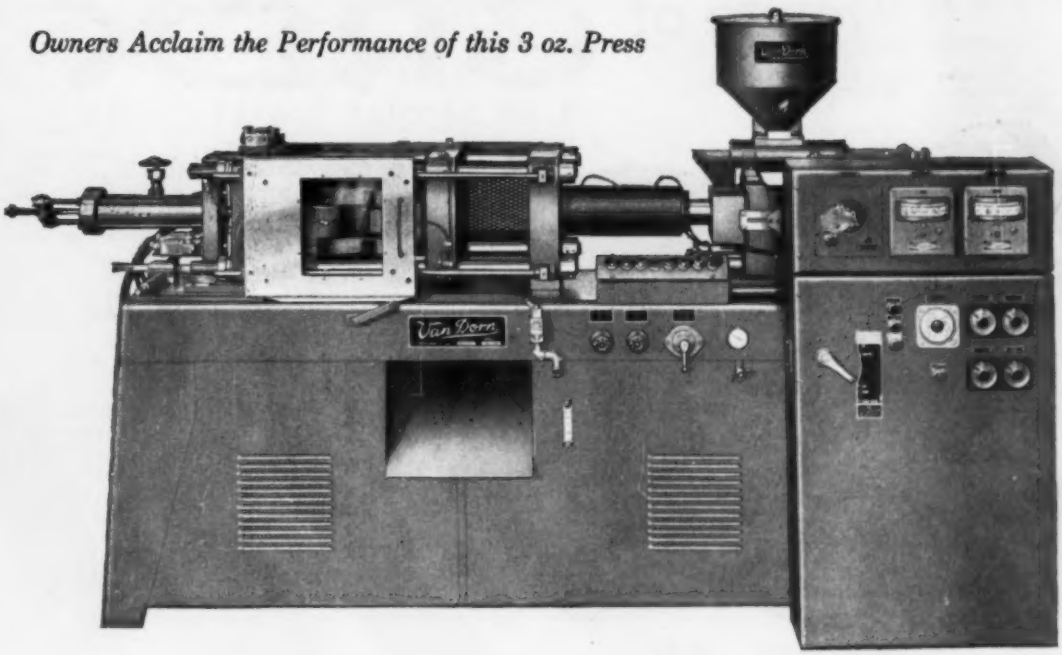
Richard C. Phelps has been appointed customer service group leader for U. S. Industrial Chemicals Co., and will supervise technical service to customers for Petrothene polyethylenes. After service with Du Pont, Spencer, and Panelyte, he joined U.S.I. as a technical service engineer.

Ralph M. Knight

Ralph M. Knight has been appointed manager of polyolefin planning and applications for U. S. Industrial Chemicals Co. He will also direct the firm's polymer service laboratories at Tuscola, Ill. Since joining the company, Mr. Knight has served as polyethylene manager, polyethylene production manager, and assistant to the vice president for production.

Because Model H-400 has proved so efficient . . . Customers have demanded a companion Van Dorn 3 oz. Plastic Press

Owners Acclaim the Performance of this 3 oz. Press



FEATURES OF

VAN DORN

H-300 INJECTION PRESS

HIGH PLASTICIZING CAPACITY up to 65 pounds plus per hour

HIGH CLAMPING PRESSURE—75 tons

HIGH SPEED OPERATION up to 1200 dry cycles per hour

FAST MOLD SET UP—toggle assembly easily adjusted for mold thickness

ADJUSTABLE TOGGLE STROKE 4″ to 8″ Standard and 4″ to 12″ optional

LARGE PLATENS accommodate molds up to 9⅛″ x 16″

FOUR TIE BARS

HYDRAULIC CYLINDER positions heater and injection mechanism for fast and convenient set up and purging

MAXIMUM OPERATOR PROTECTION with hydraulic and electrical interlock

SELECTIVE CONTROL to change from automatic to semi-automatic to hand operation

INJECTION PLUNGER & TOGGLE Speed adjustable

HYDRAULIC VALVES mounted on manifold for accessibility

ONE SHOT LUBRICATION—Standard equipment

Write for Complete Information

THE Van Dorn IRON WORKS CO.

2685 EAST 79th STREET • CLEVELAND 4, OHIO

Names in the News

Herbert R. Herman

Herbert R. Herman has been appointed chief chemist for Fiberfil, Inc., and will head up all development activities. He previously served as research chemist for Pennsylvania Industrial Chemical Corp., chief chemist for Ball Chemical Co., and with the U. S. Chemical Warfare Service.

Donald J. Collins and **Richard I. Goodkind** have been elected vice presidents in charge of marketing and administration, respectively, for Tennessee Products & Chemical Corp. Mr. Collins previously served as general sales manager and Mr. Goodkind was administrative assistant to the firm's president.

John R. Stanley has been appointed sales manager for Borden Co.'s Resinite garden hose products. He formerly served as manager, service products department, for Lily Tulip Cup Corp. Area to be covered by Mr. Stanley includes an area from the Gulf of Mexico to the Canadian border and east of the Rockies.

John H. Scherer has been appointed general manager and **Edward C. M. Homan** director of research and product development at Sun Chemical Corp.'s electrotechnical division. Mr. Scherer formerly served as vice president, marketing, and director of sales for Thermoid Co. Prior to that, he spent 19 years with the Permacel Tape Corp., where he was vice president and member of the board of directors. Mr. Homan is the former vice president of Bonded Products, Inc., and had served as vice president and technical director of Electro-Technical Products before its merger with Sun.

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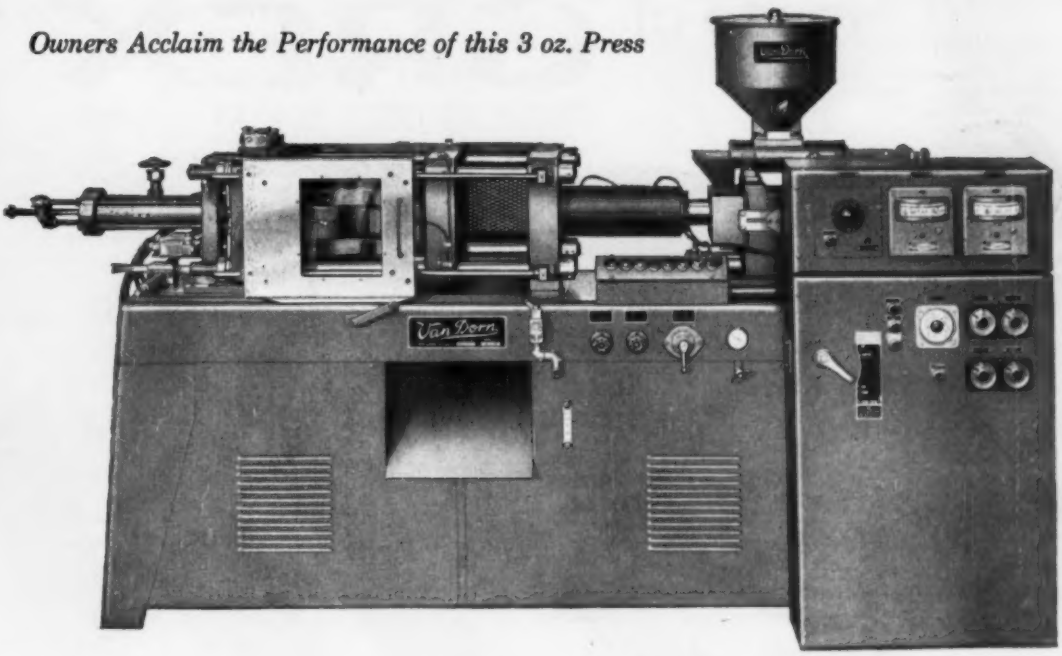

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Packs brilliant power... works in any weather... amazingly light... made of GREX®

HIGH DENSITY POLYETHYLENE

The "Chief" Power Megaphone by Industrial Television, Inc., Clifton, N. J.

The human voice can be projected enormous distances with this new, self-contained "Chief" power megaphone. Yet the entire unit—components and casing together—weighs under four pounds!

Why was GREX chosen for the casing? Industrial Television, Inc. gives three principal reasons:

GREX high density polyethylene makes a rugged lightweight molding, rigid and unyielding. GREX is weatherproof, rustproof, corrosionproof. Great heat or cold can't harm it. Thus the megaphone can be used where the going is rough: fires, police emergencies, storms . . . as well as on boats, athletic fields, beaches, playgrounds. And it's available at an attractively low price, thanks in part to this versatile plastic.

New markets can open for *you*, when GREX comes into your production picture. It costs nothing to learn how. Why not inquire today?

W.R. GRACE & CO.
POLYMER CHEMICALS DIVISION
225 ALLWOOD ROAD, CLIFTON, NEW JERSEY
3555 W. PETERSON AVENUE, CHICAGO 45, ILLINOIS

New Materials

Write item numbers on Readers' Service Card (p. 87) to obtain more information.

Flame-Retardant Laminates

Two paper-base phenolic resin laminates, grades FR-1 and FR-2, have been added to the product line of Synthane Corp. Both are flame-retardant, self-extinguishing, and feature excellent electrical and mechanical properties as well as good moisture resistance. Grade FR-1 is recommended for electrical applications such as switch gear components; while FR-2, which can be obtained with copper-coating, may be used for printed circuits, TV transformer parts, terminal boards, arc barriers, etc.

FR-2 can be warm-punched or sheared, if heated; but FR-1, which machines well, is not recommended for punching. Both are available in standard sheet sizes of 36 by 36 inches and 36 by 72 inches. Standard color is red; finish is semi-gloss. Typical properties include:

	FR-1 ⅛-in. thick	FR-2 1/16-in. thick
Flexural strength, psi.:		
Lengthwise	15,000	12,000
Crosswise	14,000	10,500
Shear strength, psi.	11,000	—
Cold Flow, %	—	0.80
Izod impact, ft.-lbs./in. notch:		
Flatwise	1.30	—
Edgewise	0.35	—
Hardness, Rockwell M.	105	—
Specific gravity	1.36	1.30
Water absorption, 24 hrs., %	1.3	1.00
Dielectric strength, short time, vibrations/min.	500	500
Constant, 1 megacycle, Cond. A	—	4.6
60 cycles	8	—
Dissipation factor, 1 megacycle, Cond. A	—	0.035
60 cycles	0.08	—
Arc resistance, Cond. A, sec.	20	80
Insulation resistance, megohms	60	—
Operating temp., max., °F.	275	—
ASTM, D-635, flame test, seconds to extinguish per cycle	5	10
Thickness, in.:		
Max.	1.5	0.375
Min.	0.030	0.030

Readers' Service Item 1

Motor Insulation Adhesive

A flexible, solvent-resistant adhesive, which has been specially formulated for laminating Mylar to resin-impregnated asbestos papers, kraft papers, varnished fabrics, and similar electrical insulating materials, has been added to the product line of Rubber & Asbestos Corp. Trade-named Bondmaster L379, this synthetic rubber-resin adhesive exhibits superior resistance to organic solvents and hot oils, and will maintain its maximum bond—and dielectric strengths even after a varnish dip.

Bondmaster L379 is available in two solids concentrations: 20% with a viscosity of 400-1,000 cps.; and 30% solids with viscosity between 4,000-7,000 cps. The formulation resistant to heat aging, and with proper laminates can pass Class B insulation tests. (96 hours at 125° C.).

Readers' Service Item 2

RONA™
SYNTHETIC
PEARL PIGMENTS
FOR COMPOUNDING INTO
• POLYETHYLENE • CASEIN
• POLYSTYRENE • POLYESTERS
• VINYL • PHENOLICS (CAST)
• ACETATE • ACRYLICS (CAST)
• NITRATE • POLYPROPYLENE
• ACRYLICS and other resins
COATING ALL SURFACES
Rona Pearl Pigments are heat and light stable, non-reactive non-corrosive, and impart high pearly luster, exceptional depth and brilliance at very low cost.
RONA LABORATORIES, INC.
East 21st and East 22nd St., Bayonne 7, N.J.
Manufacturers of Pearl Essence exclusively
Plants: Maine New Jersey Canada

TO INCREASE SALES
Nacromer®
SYNTHETIC PEARL ESSENCE
Incorporated into thermoplastics or used as a coating on any plastic, Nacromer creates unusual and lustrous pearlized surface effects. Write for complete information, if possible, supply details of your intended application.
THE MEARL CORPORATION
"World's Largest Producers of Pearl Essence"
41 EAST 42nd STREET, NEW YORK 17, N.Y.

Adhesive for Foams

A water-dispersed, reclaimed rubber-based adhesive for bonding rigid and semi-rigid plastic foams to themselves or other materials, has been placed on the market by Rubber and Asbestos Corp. Known as Bondmaster G459, this material contains about 70% solids, has a tack life of about one hour, leaves no residual odor and, for clean-up purposes, is soluble in naphtha.

The cured bond resists humidity, maintains its strength throughout a temperature range from -35 to 250° F., and withstands short-time exposures up to 350° F. This formulation contains no solvents which might attack polystyrene foam cells. It can be used for bonding insulation and sound-deadening materials, and can serve as a static-body adhesive where strong, waterproof bonds between porous or fibrous materials are required.

Bondmaster G459 meets Jan-P-101 specifications which require that cured bonds have shear strengths of 100 psi. after 24 hours water immersion (tested wet); at 140° F and 20% R.H. (tested hot); at 40° F. (tested cold); and at room temperature. Sold in five gallon pails or 55 gallon drums, this adhesive leaves no residual odors and can be applied with basic equipment such as a trowel or caulking gun.

Readers' Service Item 3

Polymerization Catalyst

Tertiary butyl hydroperoxide which can be used as a catalyst in emulsion polymerizations of vinyl monomers, polyesters, styrene, and methacrylates, has been added to the product line of Cadet Chemical Corp., and is being marketed by its distributor, McKesson & Robbins, Inc. This form, for commercial use, contains concentrations of 72% in admixture with di-t-butyl peroxide. Active oxygen, deriving from the hydroperoxide content, is 12.8%. Typical properties include:

Active oxygen, (pure compound), %	17.75
Formula	$(CH_3)_3C(OOH)$
Molecular weight	90.12
Specific gravity, 25° C	0.875-0.885
Flash point, °F	65

Readers' Service Item 4

Secondary PVC Plasticizer

A secondary plasticizer for PVC resins is being marketed under the tradename Conoco H-35, by Continental Oil Co. A high quality, synthesized product, this material offers many advantages which previously have been associated only with primary plasticizers.

If no other secondaries are present, Conoco H-35 can be used to replace up to 30% of the primary used in the system. It imparts excellent heat and light stability, superior low temperature flexibility, better compatibility than most secondaries, considerably lower initial and aged viscosities in plastisols and organosols, low extractibility in soap solutions, good wetting and internal lubrication, and excellent pigment wetting. Water-white, it lends no color of its own to the formulation. A summary of its properties includes:

Specific gravity, 60° F.	0.878
100° F.	0.864
Molecular weight	280
Bromine number	0.20
Aniline point, °C.	35
Viscosity, 100° F.:	
Cps.	13.6
SSU	83.2
Flash point, °F.	312
Blend 70% DOP/30% Conoco H-35, °F.	350
Freezing point, °F.	<-55
Distillation range, °F.	595–695
Refractive index, 20° C.	1.4901

Readers' Service Item 5

Temporary Plastic Coatings

A series of removable plastic coatings, for protection of highly finished surfaces during fabrication, handling, and shipping, have been made available by Guard Coatings Corp. Furnished in liquid form, the coatings fall into two general classes—water dispersions and fast-drying solutions—both of which can be applied with conventional coating techniques.

Typical of the company's line are Metalguards 5119 and 5219. In these formulations, the plastic is dissolved in an organic solvent which, upon exposure to air, dries to form a tough, flexible, film which has a tensile strength in excess of 1,500 psi., and an ultimate elongation of 150%. These coatings strip cleanly, have no odor, and leave no oily residue, or discoloration. Metalguard 5119 is used in applications where protection from six months to one year is desired while the 5219 formulation gives protection from one to three years. Both have excellent abrasion resistance, and stand up well under all extremes of weather.

These films dry tack-free within 15 minutes to one hour, and can be handled after 30 minutes to two hours drying time, depending on film thickness. Ultimate strength is developed after 48 hours air-dry; 30 minutes at 200° F.; or 10 minutes at 300° F. Coverage, if a one-mil film is applied, is approximately 200 square feet per gallon.

Depending on the type coating applied, one of four removal methods can be used: hand peeling; dissolving in a vapor degreaser; dissolving in a mild alkali solution; or by wetting the film with water. Metalguards 5119 and 5219 can be striped by hand. Washguards W-8514 and W-5460, which are water-dispersions producing non-peelable films, are removed with water.

Readers' Service Item 6

Polyester Premix

Atlas Powder Co. has introduced a glass fiber-reinforced polyester molding compound for use in appliance housings, tanks, tubs, and panels—where high strength and excellent surface are required. A gray, fibrous putty known as Thermaflow 105, this material competes favorably with other high-glass compounds, and in some cases can be used to replace die cast metal or sheet metal assemblies. Molded properties include:

Specific gravity	1.87
Flexural strength, psi.:	
ASTM bar	20,000
Cut specimen*	16,000
Flexural modulus, psi. x 10^6	1.6
Izod impact, ft.-lbs./in. notch:	
ASTM bar	12.0
Cut specimen*	4.5
Tensile strength, psi.	6,500
Compressive strength, psi.	18,000
Heat distortion point, 264 psi., °F.	>450
Hardness, Barcol	65
Water absorption, %:	
24 hrs., 23° C.	0.14
24 hrs., 100° C.	0.75
Mold shrinkage, in./in.:	
Compression	0.001
Transfer	0.003-0.004

*Samples were cut from molded parts at random direction to any possible glass alignment. Results shown are average of several tests.

Readers' Service Item 7

Three Epoxy Hardners

Three dicarboxylic anhydrides, which offer several distinct advantages over other organic anhydrides or amines when used as epoxy curing agents, are available from Allied Chemical Corp's National Aniline division. Known as Dodecenyl Succinic Anhydride, Methyl Nadic Anhydride, and Hexahydrophthalic Anhydride, these materials can be used in epoxy compositions for laminating, potting, encapsulating, impregnation of electrical components, preparation of tools and dies, and industrial baked goods.

Various improved characteristics can be

obtained with the proper choice of epoxy resins and one of these three curing agents. A resin with a high epoxy equivalent, cured with Methyl Nadic Anhydride, produces a hard product with a very high heat distortion temperature. Moderate to high heat distortion temperatures are obtained with Hexahydrophthalic Anhydride as the curing agent; while hard, but more flexible resins with extremely low heat distortion characteristics can be obtained with Dodecenyl Succinic Anhydride.

These materials have low-peak exotherms, low volatility, and blend easily with both solid and liquid epoxy resins at low temperatures. Physical properties of the finished product are superior to those of amine-cured systems. Methyl Nadic Anhydride and Dodecenyl Succinic Anhydride are liquids at normal temperatures, while Hexahydrophthalic Anhydride is a solid which melts at 35-36° C.

Readers' Service Item 8

Teflon-Impregnated Laminate

Another grade of Teflon-impregnated glass cloth laminate, known as Dilecto GB-108TED, has been added to the product line of Continental-Diamond Fibre Corp. This grade is designed for corrosive applications such as gaskets, seals, flexible electrical insulation, printed circuits, and tape cable.

The impregnated glass cloth is covered on both sides with a continuous Teflon film which renders it free from pin-holes. Rolls are available in widths up to six inches; lengths up to 75 feet; in thicknesses of 0.007, 0.008, 0.009; and cementable on one or both sides. Other typical properties include:

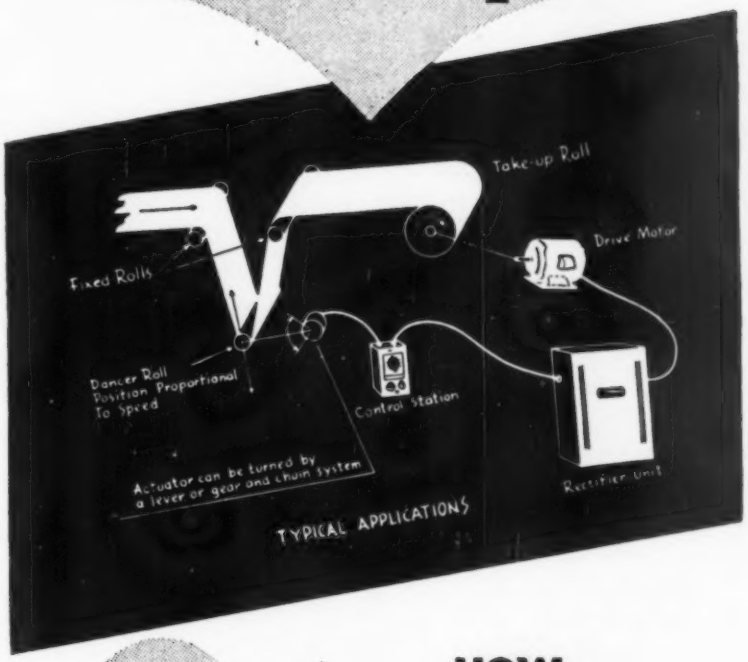
	0.009 inch	0.007 inch
Tensile strength, lbs./in. width	100	60
Dielectric strength, vpm.	2,600	2,300
Constant, 1 megacycle	2.2	2.3
Dissipation factor, 1 megacycle	0.0003	0.0004

Teflon-Impregnated Laminate

Readers' Service Item 9

Servospeed

Automatic Take-Up



Here's HOW IT WORKS ...for Textile and Plastics Processing

A small tension change positions the actuator shaft so as to call for motor speed change to restore preset tension. Thus a constant linear feet per minute windup may be achieved even though the radius of takeup roll increases with each turn to otherwise increase linear speed versus radius build-up. Speed is now made proportional to position of dancer roll and tension is held essentially constant, as is the linear rate of material travel.

These and other models of electronic motor speed control systems available from 1/50th to 2 horsepower.

WRITE

Servospeed

DIV. of ELECTRO DEVICES, Inc.

4 Godwin Ave. Paterson, N. J.

New Equipment

Write item numbers on Readers' Service Card (p. 87) to obtain more information.

Plastic Extrusion Splicer

Rigid vinyl plastic extrusions up to 2 by 1½ inches in cross-section can be spliced semi-automatically with a machine designed and built by Kel-Min Co. Air-operated from any 80-90 psi. plant supply, this machine can complete both 180° and 90° mitre splices which are as strong as the extruded member itself.

The two pieces are gripped in conforming dies which are held together by air-operated mold clamps. One mold is stationary, while the other slides laterally on rod-type ways. During manual loading, a spacer plate raises between the molds to assure that both extrusion ends are clear when the heating knife moves forward.

The heating knife also is moved by an air cylinder, and its dwell-time is controlled by an electric timer adjustable, by seconds, up to one minute. When the knife is retracted, the movable mold is pushed up to a closed position to complete the splice.

The heating element uses 110-volt, 50-60 cycle current which is controlled by a Powerstat giving variable adjustment from 0-100% of the line voltage. The splice cycle starts when the operator loads the mold halves and depresses the spacer plate switch. The heating and joining phases are automatic, and the mold clamps are released by a foot pedal at the end of the cycle.

The splicer table is ⅝-inch steel plate measuring 18 by 29 inches. Base assemblies for mold halves and other parts are fitted into surface-machined mortices for maximum rigidity and accuracy. The table is mounted on four-inch locking casters, and its height is adjustable from 31½-38½ inches. Outrigger supports can be supplied for work with exceptionally long extrusions.

Kel-Min's plastic extrusion splicer.

Readers' Service Item 21

Automatic Blow Molder

An automatic blow molding machine which uses two dual molds to effect simultaneous extrusion and molding operations, has been introduced by Auto-Blow Corp. Known as the Model 150-7, this machine is capable of forming up to 140 pounds of material per hour from a continuously running extruder.

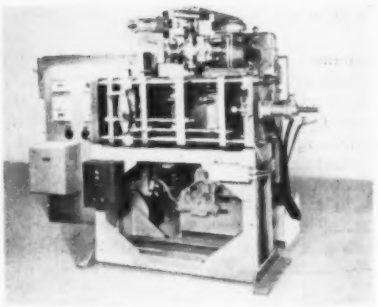
The molds are supported on three large platens which move back and forth in a single horizontal plane. Two mold halves are placed on opposite faces of the center platen, while their mates are secured to the end platens. Each mold is positioned directly beneath one of four extrusion heads whose operation is synchronized by an automatic rotary valve.

When two parisons on one side are extruded to the correct length, the mold halves close, and a mechanical linkage opens the opposite set with the same motion. While extrusion is taking place on the opposite side, the material in the closed molds is being blown to the finished form and cooled. When the object is blown, the mold halves open, the opposite set closes, and the cycle is repeated.

Molded material is constantly being cooled except for the split second required for mold closure. Since the cooling rate largely governs production speed, this alternating operation permits higher production outputs than other types of machine where the cooling part of the cycle is intermittent. Speeds up to 2,500 cycles per hour are possible.

Each extruder die has individual heat control to equalize material flow, and adjustments to regulate parison wall thickness. Operating controls, including press action, timer control, and screw speed, are located at the operator's station. Temperature controls are positioned on a panel.

Mold platens are supported at all four corners for molding accuracy, and are drilled, tapped, and key-slotted for quick mold change. These machines are sold outright without royalty restriction, and are available in three models, with or without extruder, having maximum capacities ranging from 6-12 inches in diameter.

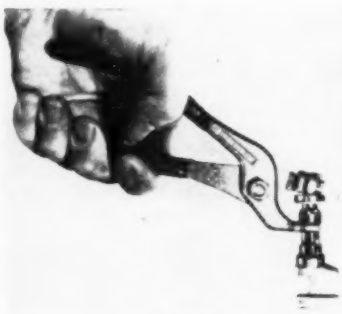


Auto-Blow Corp.'s Model 170-5 blow molder.

Over-all dimensions in feet, including extruder, are: width, 6; depth, 7; and height, 7. Other characteristics include:

Platen dimensions, in.	21.25 x 21
Clear, in.	21.25 x 15
Mold dimensions, height by width, max., in.	36 x 6
Diameter of piece, max., in.	6
Number of molds	4
Stroke, max., in.	7.25
Daylight opening, max., in.	14
Clamp pressure, lbs.	8,500
Hydraulic pressure, max., psi.	1,300
Extruded tube O.D., max., in.	2
Height to top of mold, in.	60
Floor area, approx., sq. ft.	50
Discharge height, in.	18-24
Power requirement, amps.	60
Shipping weight, less extruder, tons	2
With extruder, tons	4

Readers' Service Item 22



Edgelock spring clamp.

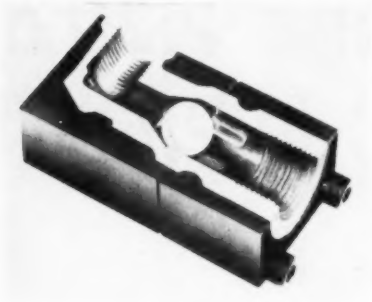
High-Tension Spring Clamp

Wedgelock Corp. has introduced a spring clamp for holding together two or more thicknesses of plastic, metal, fiberglass, wood, etc. Called Edgelock, this device has a grip capacity of 65 pounds, a jaw opening of one inch, weight approximately one ounce, and an over-all length of 2¼ inches. The spring is completely enclosed to protect the operator, and the clamp is set and released with a pair of specially-designed pliers.

Readers' Service Item 23

Fluorocarbon Check Valves

A series of steel-armoured, ball-check valves whose solid fluorocarbon bodies are resistant to almost every liquid except molten sodium, are being offered in burst-pressure ratings to 1,000 psi and above by Keystone Engineering Co. Available in either right angle or in-line constructions, they are used in severely corrosive applications where a sticking ball is the primary cause of valve failure. Trade-named Kemlon, these valves are made in ½-, ¾-, and 1-inch sizes which can be threaded or designed with 150# ASA flanged body styles.



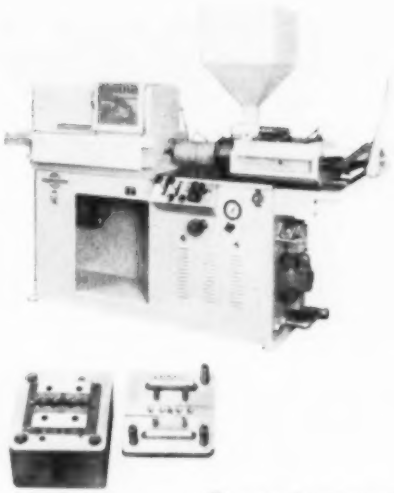
Kemlon check valve.

Readers' Service Item 24

Variable Ratio Dispenser

A variable ratio dispenser for use with two component liquid resin and hardener systems has been made available by Delsen Corp. Available as Model 390 (hand-operated) or Model 391 (motor-driven), this unit dispenses a reproducible ratio of resin to hardener; is equipped with drip-proof outlet valves; and by means of a simple lever adjustment, ratio adjustments can be made over a wide

Delsen's variable ratio resin dispenser.



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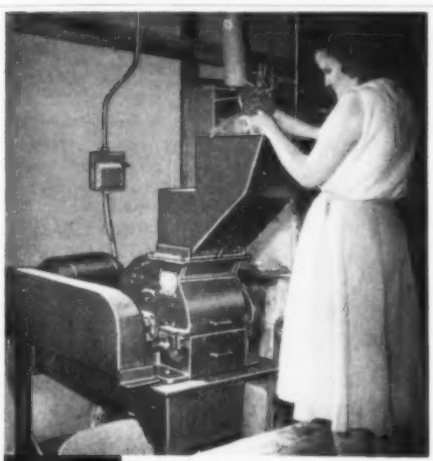
Automolders are now in quantity production at reduced prices

One single responsibility, one source of top quality will give you both machine and mold at an over-all saving of time and money. Precision toolmakers treat each item with equal care to make both work together as a package to give you the best results.

STANDARD TOOL COMPANY
225 Hamilton Street, Leominster, Massachusetts
OMNI PRODUCTS CORPORATION—Export Distributors, New York, N.Y. 6



4 YEARS SERVICE WITHOUT REPAIRS

American KC-12 Plastic Granulator Reduces up to 1/2 Ton Per Day

OWNER REPORTS

In service four years, reducing scrap polyethylene, polystyrene, Tenite, vinyls, sponge plastics, etc., this KC-12 plastic granulator has required no repairs. Only maintenance required was routine lubrication and an occasional set of new blades.

You can expect—and get—dependable service like this from American plastic granulators because they are ruggedly built. Write American today; send samples of your materials. Let American's engineers recommend an economical, money-saving solution for your requirements.

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ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS
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as high molecular weight black polyethylene telephone cable jacketing material

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Western Electric approval qualifies Monsanto as an additional source of black polyethylene for Bell System telephone cable jacketing applications.
For complete technical data, write to Monsanto Chemical Company, Plastics Division, Room 1079, Springfield 2, Mass.

Monsanto

range to allow for different formulations or changes in ambient temperature. A reference scale is provided so that ratios can be reset accurately, and a locking device permits unintentional changes in setting.

Motor driven models give rapid, automatic service and can be supplied with explosion-proof enclosures if requested. Hand operated units are for economy service, and are operated by a ratchet type crank. Both types dispense uniform batches, and eliminate weighing of resin and hardener. Output capacity is 0.2 gallons per minute, or two pounds per hour at 70 rpm. The ratios can be adjusted from 100:5 to 100:25 depending on the relative viscosities of the materials being handled: resins varying from 10-40,000 cps.; hardeners from 10-10,000 cps. Motor driven models draw 3.8 amps at 115 volts; 1.9 amps at 230 volts.

Readers' Service Item 25

Finn and Fram's glass roving cutter.

Portable Glass Roving Cutter

A portable glass roving cutter which uses up to 20 Shick Injector razor blades to obtain fiber lengths as small as ½-inch, has been added to the equipment line of Finn and Fram. Designed for use as either a primary or supplementary roving source, this unit will handle as many as six strands at one time, reducing them to chopped lengths at rates up to five pounds per minute.

The cutter can be used with single or double nozzle spray guns to effect simultaneous deposition. Glass fibers are aimed into the spray at a 45-90° angle. The spray wets the fibers and deposits both in the direction of the spray.

Although electric motors are supplied as standard equipment, air-operated units can be specified at extra cost. No tools are required for disassembly and wall brackets can be obtained as an accessory item.

Readers' Service Item 26

Test-Vac 81.

Portable Vacuum Former

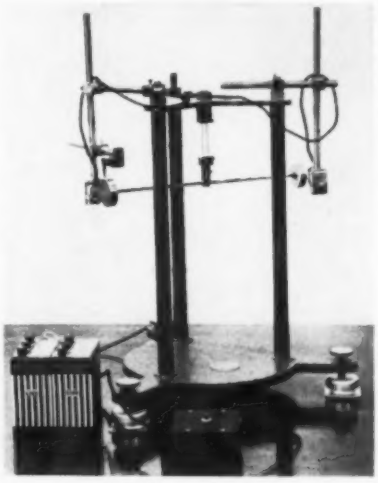
A portable vacuum molder, designed for low-cost experimental work, is available from Plast-O-Craft Co., Inc. Known as the Test-Vac 81, this machine can be obtained with either a hand- or electrically-operated vacuum pump.

Test-Vac 81 offers a nine- by nine-inch forming area, draws to a depth of four inches, and incorporates a movable frame for straight or drape forming. It is mounted on an 18 by 24-inch, Formica-surfaced base, and weighs 35 pounds.

Readers' Service Item 27

Torsion Pendulum

A torsion pendulum, designed primarily for measuring the crystallinity of fluorocarbon resins, has been developed by Baldwin-Lima-Hamilton Corp.'s electronics & instrumentation division in conjunction with the Du Pont Co. Essentially, this instrument consists of a three-post frame which can be leveled, a pendulum made up of the specimen and a weighted torsion arm assembly, and two adjustable electromagnets, energized by push-button control, to initiate oscillation of the pendulum.



Baldwin-Lima-Hamilton's torsion pendulum.

The moment of inertia value for the torsion arm assembly is stamped on one of the pendulum weights. After the system has been set in motion, oscillations are observed when one of the weights passes a stationary pointer. This machine is furnished with a calibration curve showing percent crystallinity as a function of torsion modulus.

Strips of Teflon ranging from two to six inches in length, and from 0.060-0.50 inch thick, can be accommodated. Special jaws can be supplied to handle specimens of other shape, while longer specimens require pillar extensions and correspondingly longer magnet supports.

Torsion modulus, including calibration of the Form Factor, can be determined in about 15 minutes by an experienced operator. If specimens are identical in size and shapes, only one Form Factor calculation is necessary, and measurement time can be cut to around seven minutes.

The basic torsion pendulum has overall dimensions of 18 by 18 by 24 inches, and weighs approximately 50 pounds. If used with the lamp and scale, however, a surface of approximately 48 by 24 inches is required.

Readers' Service Item 28

HAVE YOU TRIED

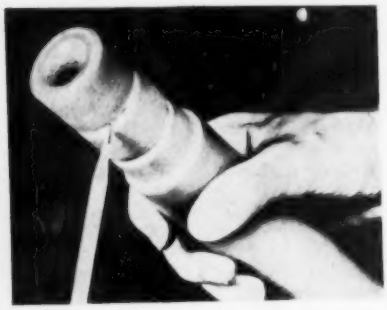
LOW COST MICA FLAKES For REINFORCING?

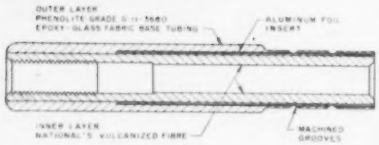
Increased electrical insulation. Compatible with all types of resins. Stocks in principal cities.

U.S. MICA CO., INC.
79 PROSPECT ST.
STAMFORD, CONN.

Plastics Applications

Write item numbers on Readers' Service Card (p. 87) to obtain more information.





Lightning arrestor has outer layer of epoxy-fiberglass wound around vulcanized fibers. An aluminum foil ground shield is wound in the covering over part of the tube length.

Epoxy-Fiber Glass Tubing

Two grades of epoxy-bonded fiber glass tubing are currently available from National Vulcanized Fibre Co.—Phenolites G-11-3680 and G-11-3681. Featuring high tensile and burst strengths, the tubing is intended for use in electrical and electronic components such as miniature coil forms, lightning arrestors for power transformers, and aircraft fuel gage probes. It can be used alone or in combination with vulcanized fibers and metal foil.

The new Phenolites comprise a rolled tube of glass fabric bonded with a high heat-resistant epoxy resin. Diameters range from ⅛-inch to 11 inches I.D., and wall thicknesses from 0.01-5.5 inches. Maximum ratio of wall thickness to inside diameter is 1:2.

Readers' Service Item 41

Vinyl Foam Skin Diving Suit

Colored skin diving suits made from closed-cell vinyl foam have been placed on the market by Skope Mfg. Corp. Said to afford greater safety than the black gear currently in use, the Skope Safety Suit reportedly is warmer than the conventional neoprene suits.

Buoyancy is still another factor. Skin divers frequently carry a rubber tube, inflated by a cartridge, as a safety measure. If the oxygen supply fails, the tube is inflated for surfacing. With the Skope suit, the diver merely releases his weight belt and surfaces automatically. As a further advantage, the suit does not require powdering before donning. It slips on easily after being dipped in water.

Available as a kit, the suit comes with directions for making hood, jacket, pants, and sox. Three sizes are marketed in white, green, blue, and red. Vinyl sponge used in its manufacture is Ensolite, a product of U. S. Rubber Co.

Ensolite vinyl sponge skin-diving suit.

Readers' Service Item 42

Polyethylene Pool Covers

Open-mesh swimming pool covers, woven from ultra-violet light stabilized polyethylene fibers, are being marketed through franchised outlets by Reeves Brothers, Inc. Tradenamed Pooltex, these covers have all of the water, mildew, and chemical resistance common to the polyolefins.

Light in weight—a 20 by 50-foot cover weighs less than 30 pounds—the woven fabric has an initial carrying capacity of 75 pounds per square foot, and thus gives protection against falling in. The open weave feature permits rain or light snow to pass through the mesh, while keeping out leaves, twigs, and other contaminants.

Reeves Brothers' Pooltex swimming pool cover.

Readers' Service Item 43

Color-Faced Laminate Parts

Taylor Fibre Co. now offers paper-based laminated plastics with black, red, green, or chocolate facings—in addition to the natural color of the material. Not only can the user tell which side is up, but the facing is expected to facilitate assembly of parts, make identification easier, and promote safety.

Parts which can use color facing advantageously are almost limitless—gears, motor terminal plates, condenser can tops, base plates for electron tubes, and the like. Color identification need not be limited to facing, but can be used in liners and base material for bars, rods, and thick sheets.

Color facing of laminates parts.

Readers' Service Item 44

readers' service

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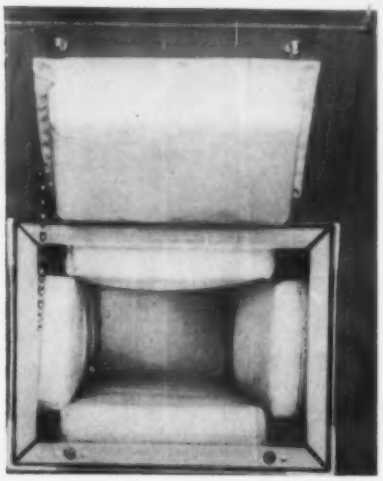
NEW YORK 17, N. Y.

Re-Usable Instrument Carriers

Re-usable shipping containers for radio receivers and other instruments have been developed by Continental-Diamond Fibre Corp. Made from vulcanized fibers and featuring a rivet construction, the containers are padded with 1½-2 inch thick polyurethane foam. This foam is covered with heavy canvas to increase its life.

The light weight of vulcanized fiber (about half that of aluminum) eliminated the need of transporting useless dead weight. Flush-mounted, screw-type latches



Interior of shipping case is padded with urethane foam.

secure the case lid, and a spring-loaded handle fits flush into the case side when not in use. Three sizes are available: 7¾ by 2⅜ by 14⅛ inches, 7¾ by 3⅜ by 14⅛ inches, and 7¾ by 5 by 24½ inches.

Readers' Service Item 45

Polyethylene-Coated Liners

Lightweight cardboard containers coated on the inside surface with a thin layer of Du Pont's Alathon 16 polyethylene are being used to ship heavy electric typewriters. Manufactured by the Mengel Co., division of Container Corp., the box cuts the over-all cube of the package by 40%, increases stacking strength by 40%, and cuts costs by 30%.

The typewriter is bolted to a solid fiber pad in the bottom of the box. The polyethylene-coated corrugated paper liner fits over the typewriter and prevents damage when the box is overturned. Polyethylene was found to be the only material that did

Electric typewriters are now shipped in light cardboard cases lined with polyethylene film.

not damage the finish of the typewriter case.

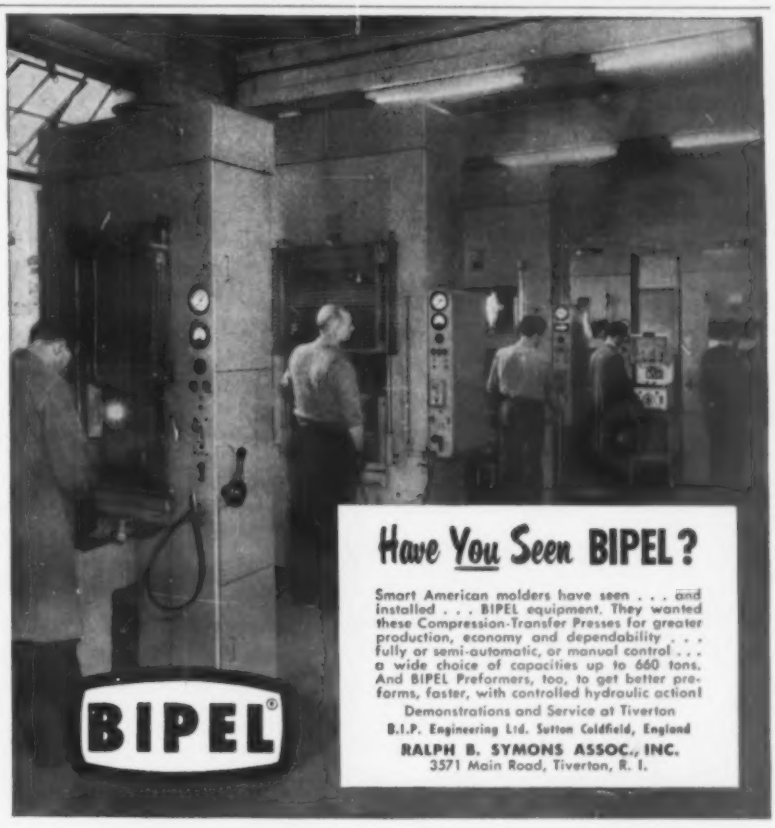
Readers' Service Item 46

Monolithic Nylon Cylinder

A 21-foot long nylon cylinder weighing over 700 pounds has been produced by Polymer Corp. Intended for use as a roller covering, the cylinder has a 16-inch outside diameter and a 13-inch inside diameter. They will be used primarily for embossing, coating, and similar processing of paper, textiles, artificial leathers, and other sheet material. Roller coverings for forming metal strip is still another application, since the nylon will not gall or scratch pre-finished metal surfaces.

Polymer Corp. states that cylinders up to 48 inches in outside diameter can be produced by the same process, and virtu-

King-size nylon cylinder.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Smart American molders have seen . . . and installed . . . BIPEL equipment. They wanted these Compression-Transfer Presses for greater production, economy and dependability . . . fully or semi-automatic, or manual control . . . a wide choice of capacities up to 660 tons. And BIPEL Preformers, too, to get better preforms, faster, with controlled hydraulic action!
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Birds of a feather go together... and so do high quality and technical service when you buy **Witco-Continental carbon blacks.** You'll get top results every time. There's a **Witcoblak**® exactly right for your plastics application. Economical, too! **Witco Chemical Company, Inc.**

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ally any wall thickness greater than one inch can be made available. They can be fabricated on standard metalworking equipment.

Readers' Service Item 47

Reinforced Plastic Floats

Five-ton pontoon "camel" floats made from polyester resins reinforced with Owens-Corning's Fiberglas have been constructed by Skagit Plastics, Inc. Designed for use as bumpers between ships lying side by side at anchor, between a ship and pier, and platforms for servicing workers, the floats are now in service at the Puget Sound Naval Shipyard, Bremerton, Wash.

Requiring little or no maintenance, the float is expected to save the government thousands of dollars. Flotation is provided by eight pontoons, each with a buoyance of 8,000 pounds. The pontoons are single-skin, glass cloth, mat and roving layups with angle and channel structural members. Fully loaded, the float draws 23 inches; empty, seven inches. It has a freeboard when loaded of 25 inches. Over-all dimensions are 34 feet by 14 feet and the working load is 12 tons.

Eight scuppers molded into the guard rail permit, fast water runoff. Manholes are built into the deck so that the pontoons are accessible for removal without bleaching or drydocking the float. In operation, the access holes are decked with Fiberglas-reinforced polyester covers.

Reinforced plastic pontoon float.

Readers' Service Item 48

THESE SIMON-CARTER MACHINES
CAN STEP UP YOUR QUALITY CONTROL

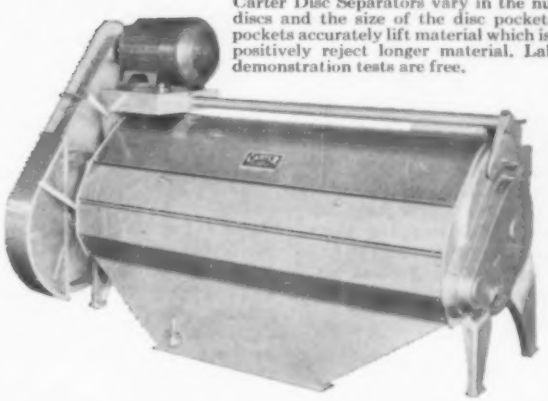
Automatic separating and sizing of plastic pellets, dice and other shapes by length, width, or thickness.

NO. 1-VT
CARTER PRECISION GRADER

For *accurate* separating and sizing of plastic resins and other free-flowing granular materials—by *width* or *thickness*. Precision Graders separate by means of cylinders of unique designs with either round or slotted perforations. Various models and sizes—including multiple units—are available.

CARTER DISC SEPARATOR

For *accurate* separating and sizing by *length*. Carter Disc Separators vary in the number of discs and the size of the disc pockets. These pockets accurately lift material which is shorter, positively reject longer material. Laboratory demonstration tests are free.



WRITE TODAY for complete information, giving us a brief description of your sizing problem.

SC **SIMON-CARTER CO.**
677 19th Ave. N.E. Minneapolis 18, Minn. STerling 9-2417

New Literature

Write item numbers on Readers' Service Card (p. 87) to obtain more information.

"Plastips." Tri-Point Plastics, Inc. 1 page. The first in a series of monthly flyers, this bulletin describes the company's operations in the extrusion and precision machining of Teflon.

Readers' Service Item 61

"Acromark Marking & Numbering Machines." The Acromark Co. 14 pages. This summarized catalog with small, line-cut illustrations lists the firm's marking and numbering machines including dies, inks, foils, heads, and other accessory equipment.

Readers' Service Item 62

"How To Color Code Plastic Parts at Low Cost." Colorite Industrial Dyers. 6 pages. The firm dyes finished parts and prototypes in any quantity. Economy is afforded through the molding of natural color material, and costly color is not wasted in sprues, gates, and runners. All plastic materials are included.

Readers' Service Item 63

"Seilon Rigid Thermoplastic Sheets," Seiberling Rubber Co. 8 pages. This illustrated booklet describes Seilon press-laminated, calendered, and extruded sheet, which can be vinyl, copolymer, styrene (high impact), polyethylene (low and high density), and Mylar. Sheet sizes and gages are listed.

Readers' Service Item 64

"Dioctyl Sebacate." Harchem Div., Wallace & Tiernan, Inc. 3 pages. This revised bulletin gives properties of the company's sebacic acid ester plasticizer for use with PVC compounds. Electrical data, physical and chemical properties are tabulated.

Readers' Service Item 65

"Model 501-H Super Pellet Ace with Wide Die." Bulletin 201. Sprout, Waldron & Co., Inc. 4 pages. This illustrated bulletin describes the machine's features, lists specifications, and explains its operation. The wide die has 5,280 $^{19}/_{64}$ inch holes, and is said to produce the greatest capacity per horsepower at the lowest die cost per ton of pellets.

Readers' Service Item 66

"Model 501-D Pellet Ace." Bulletin 100-A. Sprout, Waldron & Co., Inc. 4 pages. Described herein is the firm's gearless mill with silent V-belt drive and original hinged die casing. Specifications are listed.

Readers' Service Item 67

"Meter Mix and Dispense." H. V. Hardman Co. 4 pages. This brochure describes the Hardman "Triplematic" pump for automatic mixing, metering, and dispensing two-part resins. Also described is the company's line of epoxy and phenolic adhesives and setting compounds, as well as the Hardman Training School for "Triplematic" pump operators.

Readers' Service Item 68

"Rex Miniature Coaxial Cable." Rex Corp. 4 pages. This catalog gives full information on the company's line of both Military Specification and Commercial Specification types of coaxial cable. Temperature rating data, minimum tensile strength and elongation values are given for each type jacket supplied by the company.

Readers' Service Item 69

"Catalog of Current Films on Chemistry and the Chemical Industry." Manufacturing Chemists' Assn., Inc. 16 pages. Although the emphasis is on science education, many other groups could well utilize the films. The companies preparing these films are listed first, followed by a classified list of the films themselves. There are nine specifically about plastics, and others which would be of more than general interest to those engaged in plastics processing.

Readers' Service Item 70

"Clamps for Plastic Pipe." Cat. C-1-59. Murray Co. 4 pages. This price list covers the company's complete line of clamps for plastic pipe. The tabulation includes part number, price per hundred units, appropriate pipe size, effective clamp range, and weight in pounds per hundred units.

Readers' Service Item 71

"Valvmatic Actuator." Cat. V-200. C. H. Wheeler Mfg. Co. 4 pages. A unit which converts hand-operated valves to motor operation is described, and the six steps necessary for installation. Design, metallurgy, and maximum pressure differential data, as well as a cross-sectional diagram of the unit are included.

Readers' Service Item 72

"An Industry Helps Our Schools." Manufacturing Chemists' Association, Inc. 6 pages. This leaflet outlines the Association's work in the education field. Described are junior and senior high school programs, teacher award programs, vocational guidance and community cooperation activities.

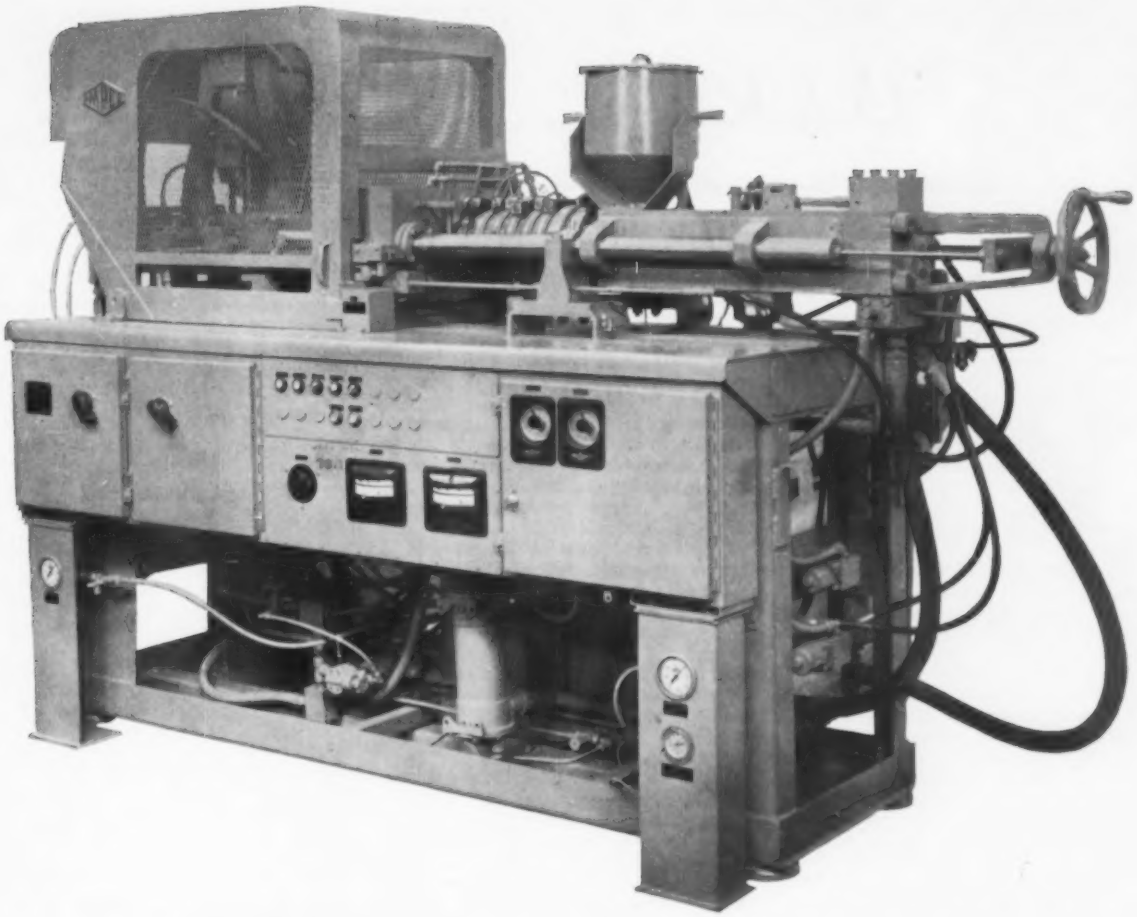
Readers' Service Item 73

"Opening Methods for Polyethylene-Wrapped Packages." Bakelite Co. 6 pages. Investigations into three opening methods are described. These include: peelable seals; perforated film; and tear tapes.

Readers' Service Item 74

"Solid Plasticizers." Monsanto Chemical Co. 7 pages. This booklet lists specifications for 14 Monsanto solid plasticizers. These include DCHP, Diphenyl phthalate, triphenyl phosphate, two Aroclors, five Montars, Santowax R, two Santicizers, and Santolite MHP.

Readers' Service Item 75



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Special Purpose Injection Molding Machine for Containerlike Molding

MODEL CA30-75

- 30-50 gram capacity
- 30 molding cycles per minute*
- shut-off nozzle for pre-pressurized molding
- simplified mold construction
- built-in die and platen cooling arrangement
- separate injection and clamp hydraulic circuits
- shock mounted control panel
- photo electric recycling monitor
- 75 ton clamp
- 9¼" stroke
- fully automatic

*dependent on material and mold construction

IMPCO IMPROVED MACHINERY INC.

NASHUA · NEW HAMPSHIRE

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Book Reviews

"Polymers and Resins." Brage Golding. D. Van Nostrand Co., Inc., Princeton, N. J. Cloth, 6¼ by 9 inches. 744 pages. Price, $15.00.

Dr. Brage Golding, who is director of research for the Lilly Varnish Co., and Visiting Professor of Engineering at Purdue University, has delivered an extensive coverage of the entire field of commercial polymers. Intended as a textbook for senior chemical engineering students, or for those working on a graduate level, "Polymers and Resins" differs somewhat from the conventional textbook in its approach to the various subjects which it contains.

Polymers are classified by chemical type and similarity, rather than by physical end-use. Organic chemistry involved in raw material production is given extensive treatment since data on commercial scale reactions are not included in undergraduate course work.

Unusual properties of polymers, such as collodial properties, elasticity, flexibility, and high viscosity, are defined in terms of linear, branched, or cross-linked molecules of high molecular weight. They are held together by primary covalent bonds, and often associated by weaker, secondary forces.

Polymers are further classified according to their mechanical and chemical behaviour. In the former case, they are grouped into three overlapping categories —elastomers, plastics and fibers. Briefly, elastomers exhibit low initial moduli of elasticity ranging from 10^1-10^2 psi.; plastics have intermediate moduli of elasticity ranging from 10^2-10^3 psi.; while fibers have high initial elastic moduli of 10^3-10^4 psi. These, of course, are not the only defining characteristics which Golding sets forth. For the chemical behaviour classification, investigations of the kinetic data concerned with the rate of disappearance of monomer and the extent of polymerization are developed.

In abbreviated form, the principal methods used to characterize polymers are presented. These involve several methods of determining molecular weights by physical means such as osmotic pressure determinations, and light scattering measurements; chemical methods, such as end-group analyses, and tracer techniques; and such indirect methods as viscosity measurements, and electron microscope analyses.

Since most commercial reactions are carried out in the liquid phase, the author concerns himself with this type of polymerization only. For convenience sake, he classifies them as initially homogeneous types, which include mass and solution polymerizations; and initially heterogeneous types, which consist of emulsion and suspension reactions.

In a series of consecutive chapters, Dr. Golding examines the different manufacturing techniques for: natural products, which may be used as obtained from nature, except for the physical treatment necessary to isolate and purify them; modified natural products, which require chemical treatment; and synthetic products, obtained by chemical synthesis.

Among the modified natural products, derivatives of rosin, cellulosics, alginic acid, and natural rubber, as well as regenerated cellulosics and protein are considered. Synthetic products are broken down into condensation and addition categories, and each of these groups is treated separately. Among the condensation polymers, technologies in the manufacture of phenoplasts, aminoplasts, polyesters, silicones, and furan resins are explained. Addition products considered are aliphatic hydrocarbons and their derivatives aliphatic vinyl and vinylidene compounds, aliphatic allyl compounds, aliphatic dienes, aromatic vinyl compounds, and cyclic unsaturated compounds.

Investigation of physicochemical behaviour, which considers the molecular phenomena responsible for the different properties of various materials, is confined principally to linear polymers since these exhibit primarily crystalline and/or amorphous characteristics. Golding prefers Alfrey's definition of a crystallite as a region in which the structural units are arranged in a regular geometric pattern. The region can contain imperfections, so long as they are local and do not affect the long range order of the system. Polymers are considered crystalline if there are enough unit cells in an ordered region to cause definite X-ray interference spots. The polymer also should possess the thermodynamic properties associated with a distinct transition phase.

Forces other than primary valence bonds, responsible for holding molecular chains together, are identified as hydrogen bonds and van der Waals forces. Hydrogen bonds are largely electrostatic in nature, and their strength increases with the increasing electronegativity of the bridged atoms.

The combination of secondary forces, named after van der Waals, is not as strong as those of the hydrogen bond. This combination consists of: attraction between dipoles; attraction between a dipole and an induced dipole; and attraction between non-polar molecules because of electron-induced fluctuating dipole moments.

First and second order transition temperatures and phenomena are discussed, as well as modification of polymers by both external and internal plasticization. This chapter also includes a brief excursion into rheology, in which the principle types of deformation are explained. The remainder of the book is devoted to a discussion of fabricating and processing techniques, and applications. The author prefers to classify the fabricating and processing methods by the physical state of the raw product which is being used. For example, solids are molded, extruded, and formed into sheets. Liquids and melts are coated, expanded or foamed, cast, and spun. Combinations of solids and liquids are laminated and impregnated. Each of these methods, as well as certain variations, are considered in detail.

Applications are discussed under the broad categories of fibers, plastics, and elastomers. The section on plastics discusses their use in contruction applications; in thermal, electrical, and optical uses; as ion exchange resins; and as adhesives, coatings, and films.

"Big Molecules." Sir Harry Melville. The Macmillan Co., 60 Fifth Ave., New York 22, N.Y. Cloth, 5 by 7½ inches, 180 pages. Price, $3.95.

Sir Harry Melville presents, in this work, a lucid and concise survey of high polymer chemistry. Starting with the basic molecular structures which can be based on the carbon atom, he shows the elementary mechanics of how straight-chain, branch-chain, and cross-linked molecules are formed, and relates these variations in structure to the physical properties of the materials thus formed.

Although large molecules consisting only of carbon and hydrogen atoms have many restricted properties, these can be modified by substituting other atoms for some of the hydrogens. For instance, substitution of a pair of CH_3 groups for the hydrogen atoms attached to alternate carbons in the basic chain yields a substance which, when vulcanized, produces butyl rubber. If one hydrogen atom attached to each alternate carbon is replaced with a chlorine atom, polyvinyl chloride results. Polyvinyl alcohol is made by substituting a single hydroxyl group at each alternate carbon.

Big molecules can be measured by a number of methods, and the author summarizes those using the electron microscope, ultracentrifuge, osmometer, a method using carbon 14, and one employing light scattering apparatus. Solution viscosities and molecular network systems are also discussed.

Fibers are approached through the several methods of making them including melt-, dry-, and wet-spinning processes, and in addition a cold-drawing method for nylons is described. The author discusses crystallization phenomena, and compares the properties of various fibers. A chapter on plastics outlines methods of fabrication, and discusses properties and applications of several of the more commonly used plastics such as polyethylene, polystyrene, PVC, etc.

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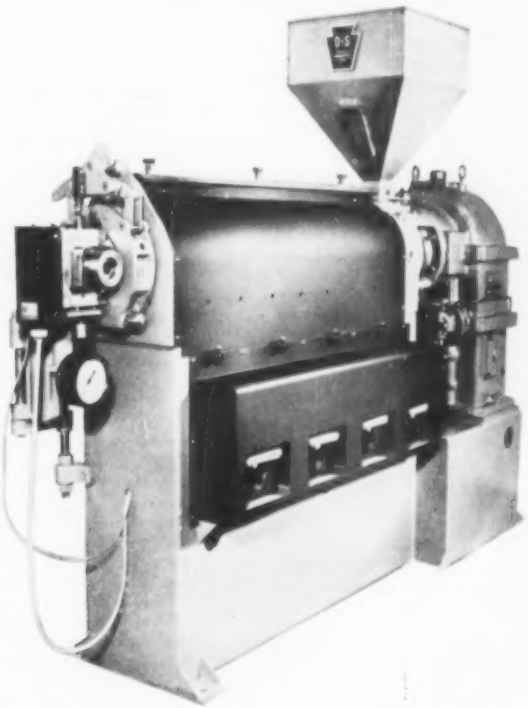

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Abstracts of Important Articles

Materials

"A Modified Vicat Type Apparatus for Measuring the Softening Point of Thermosetting Plastics and Laminates," G. F. L. Ehlers, *ASTM Bull.*, No. 236, p. 54 (Feb. 1959).

A modified apparatus is described that provides better heat transfer than the original appartus, with temperature measurements made directly on the specimen.

"A Quick Test for Carbon Black Dispersion," W. G. Best and H. F. Tomfohrde, *SPE J.*, 15, 2, 139 (Feb. 1959).

A simple microdensitometer gives curves that can be analyzed statistically to give precise measurements of dispersion in polyethylene.

"Degradation of Cellulose Acetate Films," W. K. Wilson and B. W. Forshee, *SPE J.*, 15, 2, 146 (Feb. 1959).

Tests of several commerical films showed that aliphatic ether linkage plasticizers should not be used for highest stability.

"Polyester Film - How Long Does It Last?" W. McMahon, H. A. Birdsall, G. R. Johnson and C. T. Camilli, *Materials Design Eng.*, 49, 2, 94 (Feb. 1959).

Curves show service life of Mylar-type polyester film at various temperatures and humidities.

"Engineer's Guide to Plastics," M. W. Riley, *Materials Design Eng.*, 49, 2, 103 (Feb. 1959).

A concise outline of the types of plastics available, together with their properties and general applications.

"Evaluation of Organic Peroxides From Half-Life Data," D. F. Doehnert and O. L. Mageli, *Modern Plastics*, 36, 6, 142 (Feb. 1959).

Data are given showing two scales of relative peroxide activity.

"Contribution to the study of Wearing Phenomena in Plastics used as Construction Materials," L. Rechner, *Ind. Plastiques Mod.*, 10, 9, 41 (Nov. 1958).

This is a resume of material presented in a thesis. Described are results of tests of different degrees of wear induced by sand-blast type devices on various plastics. The use of radioactive tracers and other methods of studying the effects of wear at the surface and by pronounced, deep abrasion are described. The effect of light abrasion on properties is mentioned. (In French.)

"Distribution of Moisture and Orientation in Plastics as Determined by the Le Rolland-Sorin Elasticimeter," L. M. Vicente, *Ind. Plastiques Mod.*, 10, 8, 51 (Sept.-Oct. 1958).

The LeRolland-Sorin method of determining "E" modulus by alternate flexing can also be applied to determining moisture distribution in plastics, and it makes it possible to follow variations in the properties related to variations in thickness or orientation of surface layers. The principle of the method is explained and results of tests on a number of thermoset and thermoplastic materials are given. (In French.)

"Testing of Ziegler-Polyethylene Pipe," K. Richard, G. Diedrich and E. Gaube, *Rubber & Plastics Age*, 39, 5, 364 (May 1958).

Results and the factors influencing results, are detailed of long-term creep rupture tests carried out by Farbwerke Hoechst, in Germany, on uniaxially stressed tensile bars and pipes under internal pressure. The limitations of the Bell-Telephone test for studying pipes under inside pressure are explained and the need is shown for long-term testing. Curves are presented that reflect the

In the reference system used, the first number following the magazine name is the volume number, the second is the issue number (if any), and the third is the first page on which the abstracted article appears in that magazine.

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greatly superior bursting strength of an improved high-density polyethylene at elevated temperature, as compared with normal H. D. polyethylene. The similarity at higher temperatures of the creep rupture strength curves for the two types led to a correlation method by which the resistance behaviour of the highgrade material can be predicted for longer periods at lower temperatures. Additionally tested up to 30,000 hours at room temperature the high-grade material met requirements for a life of more than 50 years at 68° F. and allowable maximum stress of 710 psi. It was suggested that the influence of processing methods may be far greater than that of the raw material; creep rupture strength at 176° F. was found to be much improved when molecules were circumferentially oriented by stretching pipe after extrusion. It is emphasized that the possibility of improving the strength of polyethylene pipe by molecular orientation has not received proper consideration.

"Materials for Long Range Missiles and Space Vehicles," W. A. Mrazek, *SPE J.*, 15, 3, 211 (March 1959).

Advancing missile designs require composite materials and unorthodox designs, fabrication techniques, and materials applications.

"The Present Position of Technical Melamine Molding Powders and Their Applications," W. Lohmann, *Kunststoffe*, 48, 9, 483 (Sept. 1958).

Important recent additions to the range of thermoset molding materials are the so-called technical melamine molding powders containing wood-flour, textile fibers and shreds, stone powder, asbestos and glass fibers as fillers, instead of cellulose. They now come under German Standards specifications. Hints are given on processing them, and their special properties and applications, particularly for electrical purposes, are described. (In German.)

"Polyethylene Environmental Stress-Cracking by the Bent Strip Test Method," K. A. Kaufmann, *Modern Plastics*, 36, 7, 146 (March 1959).

Results are given for the proposed ASTM test method.

Equipment

"High Frequency Welding Equipment Made on the Premises," K. Brandenburger, *Kunststoffe*, 48, 8, 391 (Aug. 1958).

How a firm can make its own high-frequency welding electrodes on its own premises with commercially available materials, devices, and prefabricated parts is explained and described. (In German.)

"Modern Plastics Machinery," O. F. Bartoo, *Trans. Plastics Inst.*, 26, 65, 25 (July 1958).

The over-all picture of the current position in plastics machinery concerns mainly European designs since, as the author stresses, the majority of recent novel and original constructions have been of European origin, rather than American. Machinery for "mechanized" hand lay-up work, improved plasticizing cylinders, applications of screw plasticizing, extruders, vacuum-forming machines, a melt-coating machine for coating paper, and compounding equipment are considered.

"Accident Prevention on Injection Machines," K. Treydte and O. Liebhardt, *Plastverarbeiter*, 9, 1, 1 (Jan. 1958).

New German equipment is being designed to meet the provisions of the Accident Prevention Order for new plastics injection molding machines that came into force at the end of 1956, and safety devices are being supplied for use on older models. For financial and other reasons, a medium-size firm of injection molders decided to design its own safety measures. The devices adopted for varied equipment, including six different makes, are described. (In German.)

"Determining Viscosity of Melted High Polymers with the Aid of a Supersonic Device," M. Chatain, G. Hery and J. Prevat, *Ind. Plastiques Mod.*, 10, 9, 32 (Nov. 1958).

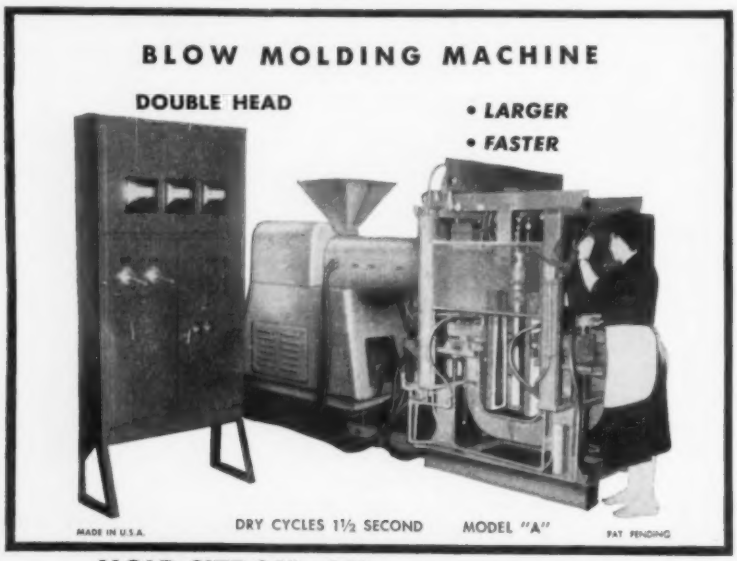
The design and principle of the Ultraviscoson, made by Rich-Roth, of Hartford, Conn., are described. The method of operation and the results obtained on different plastics are discussed. (In French.)

"Custom-Made Machine Pays Off on Difficult Jobs," S. E. Tinkham, *Modern Plastics*, 36, 7, 130 (March 1959).

Description of a 16-ounce automatic molding machine and its applications.

"Types of Electrodes for High Frequency Welding of Plasticized PVC Sheet. The Cutting Edge," K. Brandenburger, *Kunststoffe*, 48, 10, 491 (Oct. 1958).

The appearance of high-frequency welded plasticized PVC sheet largely depends on the nature and finish of the lower edge of the electrode. Various types of electrodes are described. The possible ways of arranging the cutting edge are discussed, as are the welding pressure and



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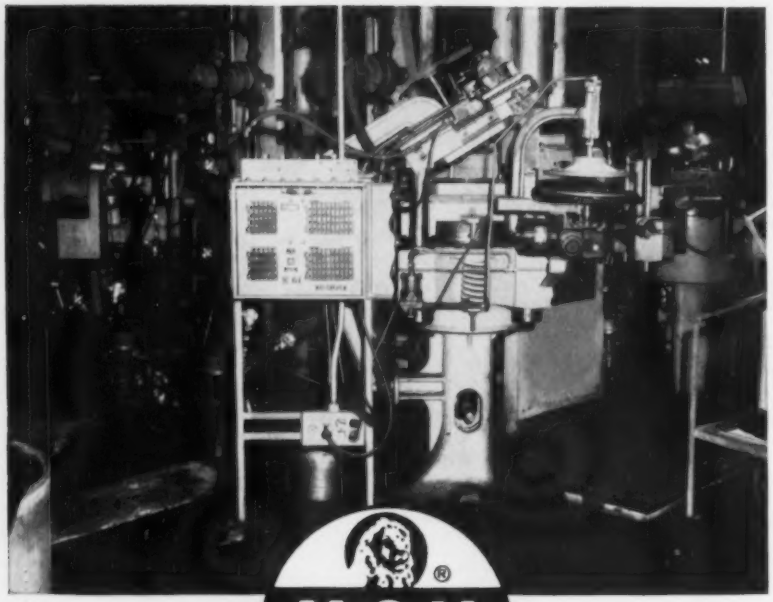

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the right type of plastic support or underlay to be used during welding. (In (German.)

Processing

"Bonding Light Metals with Plastics" A. Matting and K. F. Hahn, *Kunststoffe,* 48, 10, 444 (Oct. 1958).

This article aims at encouraging German manufacturers to overcome the lag behind research in industrial application of adhesive bonding of metals. The authors consider the role of structural parts; the effect of heat on tensile testing; the effect of continuous static load on creep characteristics of the plastic and strength of the bond; behavior under impact; and influence of radiation by a Cobalt-60 isotope on bond properties. (In German.)

"Mechanical Flash Removal from Mass-Produced Moldings," H. Derigs, *Kunststoffe,* 48, 10, 489 (Oct. 1958).

A process to mechanically remove light flash from fragile and complicated thermoset moldings uses a Wheelabrator-type drum polishing machine converted for the purpose. The plastic parts are clamped to supports arranged in open, perforated, hexagonal or octagonal aluminum drums, each of which will hold from 60-80 parts. Polishing takes from 4-8 minutes and, with proper precautions, there are few rejects. (In German.)

"Adhesive Bonding of Metals, Part II. Influence of Various Factors on Bond Strength," H. Peukert, *Kunststoffe,* 48, 10, 453 (Oct. 1958).

Part I of this article dealt with the physico-chemical principles of the bonding technique, the necessary pre-treatment of the metal surface and the various synthetic resin adhesives. In the present section, the various factors affecting bond strength are discussed on the basis of German and foreign test results. (In German.)

"Problems with Premix Moldings—Part I," R. B. White and R. S. Jackson, *Modern Plastics,* 36, 7, 117 (March 1959).

This first section of a three-part article deals with causes and remedies for strength variations and voids.

Fabricating Silicone Laminates to Get the Most Strength," L. W. Breed, Howard Christie, Calvin Bolze, and Fred Baiocchi, *SPE J.,* 15, 3, 220 (March 1959).

Various fabricating variables are analyzed for effects on laminate strength.

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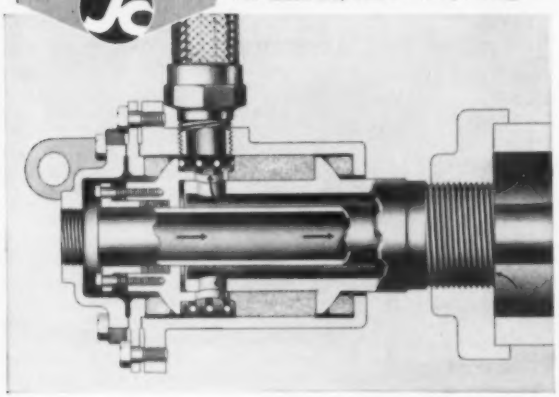

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Patent Digest

Materials

Copolymers of Vinyl Chloride and 2-Chloroallylidene Diacetate. No. 2,853,477. Bruce R. Thompson, Charleston, and Harry A. Stansbury, Jr., South Charleston, W. Va. (to Union Carbide Corp., New York, N.Y.).

A monomer mixture is formed with vinyl chloride and 2-chloroallylidene diacetate. This mixture is heated in the presence of a peroxide catalyst to 30-70° C. until at least 75% of the 2-chloroallylidene diacetate has copolymerized with the vinyl chloride.

Polysiloxane Compound. No. 2,853,503. Donald L. Bailey, Snyder, and Francis M. O'Connor, Kenmore, N.Y. (to Union Carbide Corp., New York, N.Y.).

This compound is a linear siloxane polymer consisting of one ethyl vinyl siloxane unit and two trimethyl siloxane units.

Compositions Derived From Polymers Having a Basis of Acrylonitrile. No. 2,854,436. Paul Jacques Corbiere and Pierre Mosse, Lyons, France. (to Crylor, Paris, France).

This composition contains a polymer of acrylonitrile, at least one ethylenically unsaturated monomer, and organic solvent, and tin in the form of a stannous salt.

Polysiloxane Compound. No. 2,851,472. Donald L. Bailey, Snyder, and Ronald M. Pike, Grand Island, N.Y. (to Union Carbide Corp., New York, N.Y.).

This compound is a linear siloxane polymer consisting of one trimethylsiloxy vinyl siloxane unit and two trimethylsiloxane units.

Orange Pigment. No. 2,848,461. Roy A. Pizzarello, Mount Vernon, N. Y., and Alfred D. Schneid, New Milford, N. J. (to Interchemical Corp., New York, N. Y.).

One mole of symmetrical ortho phthalyl dichloride and two moles of 1-amino-4-methoxy-anthraquinone are condensed in an inert solvent at a temperature not in excess of 110° C. An inert gas is blown across the mixture to remove the HCl fumes. The resulting pigment imparts a bright orange color when dispersed in cellulose acetate.

Catalytic Production of Polyethylene Terephthalate. No. 2,850,483. James B. Ballentine, Kenneth R. Lea, and William K. Easley, Decatur, Ala. (to Chemstrand Corp., Decatur, Ala.).

Ethylene glycol and dimethyl terephthalate are reacted in the presence of a catalytic amount of a saturated, aliphatic, dicarboxylic acid containing from 2.10 carbon atoms. The reaction is carried out at a temperature between 100-250° C. until no further methanol is liberated. It is continued at elevated temperatures and reduced pressures until a linear polyester having a melt viscosity of 600-3,000 poises is obtained.

Copolymers of Vinyl Lactams and Trimethallyl Isocyanurate. No. 2,848,440. Clyde W. Davis, Antioch, and Forrest A. Ehlers, Walnut Creek, Calif. (to Dow Chemical Co., Midland, Mich.).

A major proportion of the vinyl lactam monomer is polymerized in the copolymer molecule rendering the material dye-receptive, water-insoluble, and normally solid.

Process for the Production of Polyureas. No. 2,852,494. Wolfgang Lehman, Leverkusen-Bayerwerk, and Heinrich Rinke, Leverkusen, Germany. (to Farbenfabriken Bayer A.G., Leverkusen, Germany).

A diprimary aliphatic diamine salt is decomposed into the corresponding diamine by mixing an alkali metal hydroxide with an admixture of the diamine salt, water, an aliphatic diisocyanate, and an inert organic solvent at about 2° C. A chemical reaction is effected between the diamine and diisocyanate to form a polymer.

Amino-Aldehyde Resins. No. 2,851,442. Clarence A. Michaud, Springfield, N. J. (to Celanese Corp. of America, New York, N. Y.).

Urea and formaldehyde are reacted together in the presence of an alkaline catalyst. This product, in turn, is reacted with 3-methoxy butanol in the presence of an acid catalyst to form a 3-methoxy butanol-modified amino-aldehyde resin.

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Prices, 25c each.
—The Editor

Ureido-Modified Polymers and Their Preparation. No. 2,852,493. Donald A. Smith and Cornelius Unruh, Rochester, N.Y. (to Eastman Kodak Co., Rochester, N.Y.).

This compound consists of ureido alkyl carbamates and ureido aryl carbamates of a hydroxyl containing polymer selected from the group consisting of polyvinyl alcohol, at least partially hydrolyzed cellulose ethers, celluose, and incompletely esterified cellulose esters.

Polymerization Process. No. 2,851,451. Robert Everett Foster, New Castle, and Gerald Messner Whitman, Hockessin, Del. (to E. I. du Pont de Nemours & Co., Wilmington, Del.).

In the preparation of normally solid, ethylene polymers, the reaction is carried out in the presence of a polymerization catalyst comprising a reduced, anhydrous, phosphomolybdic acid which contains molybdenum at a valence state less than four.

Polymerization of Chlorotrifluoroethylene. No. 2,851,407. Mortimer H. Nickerson, Springfield, Mass.

Monomeric chlorotrifluoroethylene is dispersed in water containing an ultraviolet light sensitive peroxy compound. The dispersion is fed to a reactor where polymerization is initiated by irradiating the mixture with ultra-violet light to effect decomposition of the peroxy compound.

Aqueous Thermosetting Adhesive Comprising a Salt of Sulfonated Polystyrene and an Amine-Aldehyde Resin. No. 2,852,480. Oscar P. Cohen, Longmeadow, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

An adhesive base consisting of 100 parts of a water-dispersible, fusible, amino resin; and from 0.01-10 parts of a stable, water-soluble salt of sulfonated polystyrene.

Terpolymer of Maleic Anhydride, Vinyl Acetate and Alkyl Acrylate. No. 2,855,387. Gerald R. Barrett, Winchester, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

Alkyl groups of the alkyl esters contained in this terpolymer contain from 1-8 carbon atoms. The ratio of vinyl acetate to maleic anhydride on a mol percent basis varies from 52-48% to 50-50%. The amount of ester varies from 1-30 mol percent.

Melamine Process. No. 2,855,396. John A. Sheered, New Orleans, La. (to Monsanto Chemical Co., St. Louis, Mo.).

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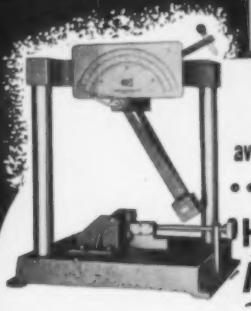

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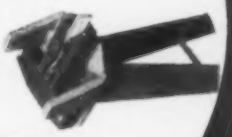

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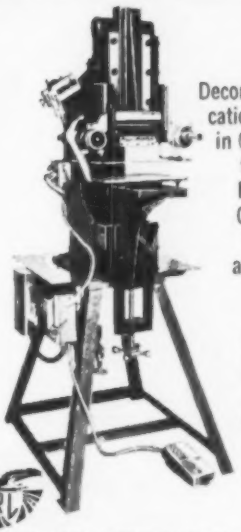

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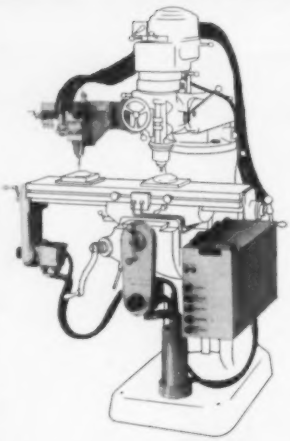

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Liquid Aromatic Diamines as Curing Agents for Epoxy Ether Resins. No. 2,853,467. Albert Bloom, Summit, and Eldred V. Welch, North Plainfield, N.J. (to General Aniline & Film Corp., New York, N.Y.).

This heat curing composition consists of a liquid glycidyl polyether of a dihydric phenol mixed with a phenylenediamine catalyst and an aromatic diamine.

Copolymer of Acrylonitrile and Cyano Ether-Esters. No. 2,854,440. Roland J. Kern, Miamisburg, O. (to Monsanto Chemical Co., St. Louis, Mo.).

This copolymer consists of 2-(2-cyanoethoxyl) ethyl acrylate. It contains between 40-90% by weight of the acrylate, with the balance being acrylonitrile.

Vinyl Acetate-Vinyl Sulfofluoride Co-Polymers. No. 2,855,383. Otto Scherer and Karl Heinz Kahrs, Frankfurt am Main. (to Farbwerke Hoechst A.G. vormals Meister Lucius & Bruning, Frankfurt am Main, Germany).

This copolymer contains from 12-50 parts of vinylsulfofluoride and, correspondingly, from 88-50 parts of vinyl acetate.

Process For Producing Linear Polyureas. No. 2,855,384. Wolfgang Lehmann and Heinrich Rinke, Leverkusen-Bayerwerk, Leverkusen, Germany. (to Farbenfabriken Bayer AG, Leverkusen, Germany).

Substantially equal proportions of a diamine carbamate salt and an alkylene diisocynate are reacted at a temperature of at least 70° C. to make a linear polyurea.

Polyamide Articles Incorporating Molybdenum Disulphide. No. 2,855,377. Louis L. Stott, Reading, Pa. (to Polymer Corp., Reading, Pa.).

A high-melting polyamide incorporating a small quantity of molybdenum disulphide in fine particle formed is used to make a machine part.

Equipment

Process and Apparatus for Converting Thermoplastic Material to Granular Form. No. 2,850,764. P. J. Evans, Welwyn Garden City, J. W. F. Carr, Luton, W. S. Gilmour, Welwyn, and A. Kennaway, London, England. (to Imperial Chemical Industries, Ltd., Millbank, London, England).

This apparatus consists of an extruder which discharges, through a plurality of orifices, into a cooling bath. The bath contains a rotary cutter which reduces the extruded material to granular form. The granules are entrained in the circulating fluid which serves as a vehicle for their removal.

Processing

Fibrous Article and Method of Preparing the Same From Polymeric Films. No. 2,853,741. John E. Costa and Edgar W. Le Boeuf, Midland, and Lloyd E. Lefevre, Bay City, Mich. (to Dow Chemical Co., Midland, Mich.).

A film of normally crystalline polymer is super-cooled, oriented unilaterally, and shredded in an amount sufficient to break the film into a coherent, longitudinally fibrillated, fibrous web. The fibroid segments of the web are in random association but not separated from one another.

Process for Preparing Dentures Provided With Soft Linings. No. 2,851,734. Hermann Schnell and Wilhelm Becker, Leverkusen, Germany. (to Farbenfabriken Bayer A.G., Leverkusen, Germany).

A copolymer of methyl methacrylate and butyl acrylate in soft, resilient sheet form houses a polymeric unsaturated ester dough which is dispersed in a monomeric, unsaturated ester. The combination is placed in a denture mold. After heat has been applied, the monomer and polymer become a strong, hard denture body, to which the resilient sheet is firmly bonded.

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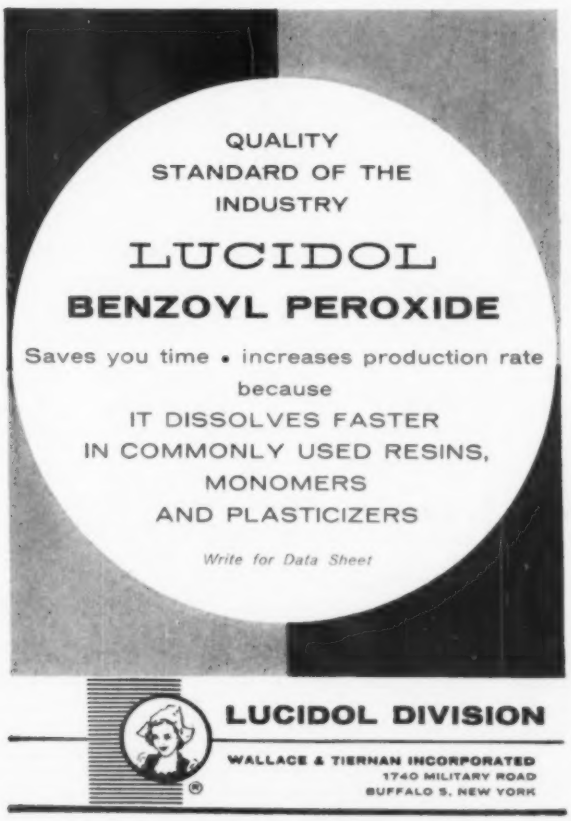

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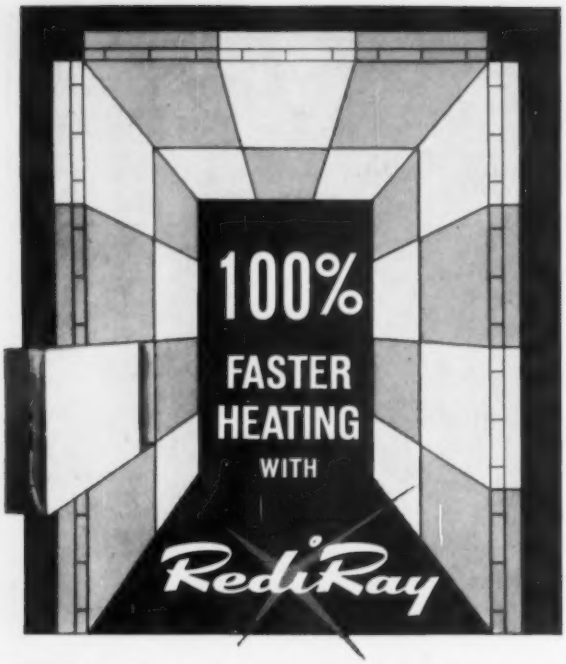

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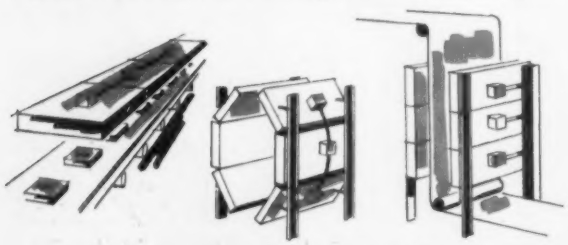

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Catalysts

Cadet Benzoyl peroxide, granules	lb.	$1.08	/ $2.00
99% purified	lb.	4.00	/ 5.00
Cadox BC	lb.	4.00	/ 13.50
BCP	lb.	.77	/ .86
BDP	lb.	1.00	/ 2.30
BSA	lb.	1.75	/ 2.50
BSD, BSG, SG	lb.	2.90	/ 5.00
BTP	lb.	.95	/ 2.25
TBH	lb.	2.00	/ 3.75
TS 40	lb.	4.57	/ 6.00
50 paste	lb.	4.45	/ 5.50
Lauroyl peroxide	lb.	1.90	/ 3.50
Hercules cumene hydroperoxide	lb.	.50	/ 1.25

Coating Resins

Celanese PVA emulsions,			
Copolymers	lb.	.18	/ .31
Homopolymers	lb.	.16	/ .29

Colors

Columbian Carbon colors:			
Coblac 405	lb.	.9675/	1.035
DD Sol	lb.	.6575/	.725
Industrial	lb.	.7725/	.84
Coethloblak CK	lb.	1.1175/	1.185
Coresinblak No. 3	lb.	.7175/	.785
Covarnishblak			
AR	lb.	.71 /	.735
BJ	lb.	.57 /	.595
BK	lb.	.62 /	.645
Covinylblak			
BA	lb.	1.05 /	1.075
BD	lb.	1.07 /	1.095
BF	lb.	.77 /	.795
BH	lb.	.73 /	.755
BM	lb.	.85 /	.875
Cowaxblak			
BV-25	lb.	.57 /	.595
CB-18	lb.	.69 /	.715
CM-83	lb.	.53 /	.555
DC Globlak	lb.	.8528/	.92
DCV Coblak	lb.	.8875/	.955
Paint grades,			
140	lb.	.1075/	.195
999	lb.	.26 /	.35
Excelsior	lb.	.135 /	.22
Molacco	lb.	.0625/	.135
Beads	lb.	.0575/	.125
Neo Spectra Mk. III	lb.	.47 /	.56
Raven 11	lb.	.1075/	.195
15	lb.	.0775/	.19
Statex	lb.	.0725/	.14
Beads	lb.	.0625/	.13
Superba	lb.	.36 /	.45

Mica

Mykroy, 38A, round rods,			
18 inches long	ea.	.90	/ 15.50
29 inches long	ea.	1.50	/ 17.50
Square rods,			
18 inches long	ea.	.75	/ 4.90
29 inches long	ea.	1.22	/ 6.75
38S, round rods,			
18 inches long	ea.	1.26	/ 21.70
29 inches long	ea.	2.10	/ 24.50
Square rods,			
18 inches long	ea.	1.05	/ 6.86
29 inches long	ea.	1.71	/ 9.45
38A sheets,			
14.75 x 19.5 inches	ea.	5.35	/ 26.50
19.5 x 29.75	ea.	10.70	/ 53.25
38S sheets,			
14.75 x 19.5	ea.	7.49	/ 37.10
19.5 x 29.75	ea.	14.98	/ 74.55

Plasticizers

Benzoflex 9-88	lb.	.27	/ .50
2-45	lb.	.26	/ .49

Resins & Molding Compounds

Polyethylene

Fortiflex, Group I, nat	lb.	.38	/ .42
Colors	lb.	.44	/ 1.01
Black	lb.	.44	/ .48
Group II, nat	lb.	.40	/ .44
Colors	lb.	.46	/ 1.03
Black	lb.	.46	/ .50
Group III, nat	lb.	.42	/ .46
Colors	lb.	.48	/ 1.05
Black	lb.	.48	/ .52
General purpose black	lb.	.405	/ .445

Styrenes

Styron 330, 369, and 777, nat	lb.	.28	/ .295
Special colors	lb.	.315	/ 1.00
440, 440M, 475, 475M, nat	lb.	.31	/ .325
Special colors	lb.	.345	/ 1.00
480 nat	lb.	.385	/ .415
Special colors	lb.	.425	/ 1.00
666, 666M, 689, and 683, Crystal (K-27)	lb.	.215	/ .23
Special colors	lb.	.255	/ 1.00
700 Crystal	lb.	.2425/	.2575
Special colors	lb.	.2725/	1.00

CALENDAR of COMING EVENTS

May 22
SPE Northern Indiana Section RETEC. Plastics in Electrical Insulation. Fort Wayne, Ind.

May 25-28
Design Engineering Show and Conference. Convention Hall, Philadelphia, Pa.

June 11-13
Manufacturing Chemists' Association. 87th Annual Meeting. The Greenbrier, White Sulphur Springs, W. Va.

June 17-27
International Plastics Exhibition. British Plastics. Olympia, London, England.

June 19
SPE Detroit Section RETEC. Plastics in the Automotive Industry. Detroit, Mich.

July 6-10
Gordon Research Conferences. Polymers. Colby Junior College. New London, N.H.

August 9-12
ASME-AICE Heat Transfer Conference. University of Connecticut, Storrs, Conn.

September 10-11
ASME Wood Industries Conference. Multnomah, Portland, Ore.

October 7
SPE Cleveland Section RETEC. Vinyl Plastics. Cleveland, O.

October 16
SPE Buffalo Section RETEC. Plastics Finishing. Niagara Hotel, Niagara Falls, N.Y.

November 8-10
Toy Production Show (originally scheduled for April 14-16). New York Trade Show Building, New York, N.Y.

Domestic Production and Sales of Plastics and Resin Material, 1958 Totals and January, 1959

Following are the preliminary 1958 totals and the estimated January, 1959 statistics for domestic production and sale of plastics and resinous materials. Units listed are in pounds, dry weight, unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily restricted to the protective coating industry.

Production volumes for 1958 fluctuated as follows: cellulosics, −4%; phenolics −5%; ureas, +3%; styrenes, +7%; vinyls, −2%; coumarone indene, −6%; polyesters, +11%; polyethylene, +17%; miscellaneous, +6%; and grand totals, +5%. The sales fluctuation curve for the same period shows a very similar profile. Figures for January, 1959, in both production and sales, show increases over the preceding year which range from 12–36%.

	Preliminary Totals, 1958		January, 1959	
	Production	Sales	Production	Sales
Cellulose Plastics:[1]				
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	17,035,629	16,331,121	1,781,417	1,479,147
Sheets, 0.003 gage and over	18,420,697	17,742,891	1,894,952	1,602,610
All other sheets, rods, and tubes (including other cellulose plastics)	9,192,718	8,592,475	903,928	772,938
Molding and extrusion materials (including other cellulose plastics)	93,358,219	90,531,379	8,810,467	8,409,638
Nitrocellulose sheets, rods, and tubes	2,936,956	3,136,499	293,683	175,895
TOTALS	141,358,219	136,334,365	13,684,447	12,440,228
Phenolic and Other Tar-Acid Resins:				
Molding materials[1]	169,133,452	161,280,657	16,932,792	16,579,486
Bonding and adhesive resins for—				
Laminating (except plywood)	64,386,009	42,884,249	5,819,302	3,750,409
Coated and bonded abrasives	12,548,309	11,618,095	1,204,523	1,156,054
Friction materials (brake linings, clutch facings, and similar materials)[2]	13,473,540	12,622,439	1,282,950	949,032
Thermal insulation (fiber glass, rock wool)	46,655,592	46,865,113	3,529,179	3,499,079
Plywood	51,410,786	43,385,515	4,597,142	3,597,393
All other bonding and adhesive uses	41,364,512	40,397,565	5,371,060	5,061,674
Protective-coating resins unmodified and modified except by rosin	28,692,936	24,178,678	2,376,360	1,764,468
Resins for all other uses	32,943,528	26,639,027	4,290,683	3,910,428
TOTAL	460,608,664	409,871,338	45,403,991	40,268,023
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	33,214,764	32,183,994	2,820,450	2,953,105
Paper-treating and paper-coating resins	24,808,555	23,312,510	2,247,441	1,987,280
Bonding and adhesive resins for—				
Laminating	31,794,681	27,584,722	2,557,192	1,985,668
Plywood	100,406,055	99,929,899	9,600,873	8,516,576
All other bonding and adhesive uses	11,600,174	11,681,181	1,921,435	1,769,853
Protective-coating resins, straight and modified	31,832,324	25,285,071	3,080,975	2,291,696
Resins for all other uses, including molding	90,509,277	88,344,341	9,034,819	9,059,724
TOTAL	324,165,730	308,321,718	31,263,185	28,563,902
Styrene Resins:				
Molding materials[1]	442,210,640	449,647,713	46,325,171	43,132,951
Protective-coating resins, straight and modified	96,804,990	91,769,733	7,874,259	6,581,285
Resins for all other uses	156,350,927	124,251,341	17,233,027	15,937,373
TOTAL	659,366,557	665,668,787	71,432,457	65,651,609
Vinyl and Vinyl Chloride Resins:[3]				
Polyvinyl chloride and copolymer resins (50% or more PVC) for—				
Film (resin content)		71,326,179		6,129,858
Sheeting (resin content)		69,143,657		7,621,620
Molding and extrusion (resin content)		214,365,855		23,097,755
Textile and paper treating and coating (resin content)[3]		63,047,819		5,165,119
Flooring (resin content)		113,584,060		11,364,925
Protective coating (resin content)		28,921,181		2,496,780
All other uses (resin content)		69,533,298		7,080,229
All other vinyl resins for—				
Adhesives (resin content)		47,993,976		2,955,854
All other uses (resin content)		123,199,926		13,385,527
TOTAL	821,369,035	801,115,951	83,297,609	79,297,667
Coumarone-Indene and Petroleum Polymer Resins	236,836,661	234,930,154	20,186,878	20,950,601
Polyester[4] Resins:				
For reinforced plastics	98,097,919	89,021,507	8,983,043	7,339,855
For all other uses	15,763,638	13,313,666	1,753,934	1,689,909
TOTAL	113,861,557	102,335,173	10,736,977	9,029,764
Polyethylene Resins:				
For film		312,923,217		29,538,844
For all other uses		526,708,704		50,858,106
TOTAL	864,001,034	839,631,921	87,329,294	80,396,950
Miscellaneous Synthetic Plastics and Resin Materials:				
Molding Materials[1, 4]	45,883,985	45,489,489	4,343,627	2,692,208
Protective-coating resins[5]	18,665,858	8,210,498	2,823,302	2,293,379
Resins for all other uses[6]	144,102,763	129,274,360	15,631,753	13,909,348
TOTAL	208,652,606	182,974,347	22,798,682	18,894,935
GRAND TOTALS	3,866,220,063	3,681,183,754	399,370,698	371,221,816

[1] Includes fillers, plasticizers, and extenders.
[2] Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3] Includes data for spreader and calendering-type resins.
[4] Includes data for acrylic, nylon, silicone, and other molding materials.
[5] Includes data for epichlorohydrin, acrylic, silicone, and other protective-coating resins.
[6] Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.
[7] Included with "All other bonding and adhesives uses."

SOURCE: United States Tariff Commission, Chemical Division.

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News about

B.F.Goodrich Chemical *raw materials*

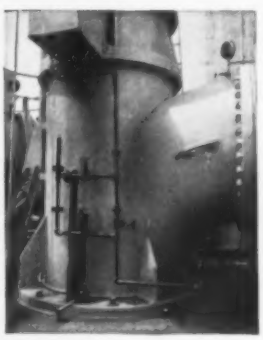
AT FLORIDA POWER & LIGHT'S CUTLER GENERATING STATION

How pipe of Geon helps cut maintenance

The large photo shows 3½" pipe made from Geon rigid vinyl material that is used to feed an aqueous solution of chlorine into sea water just ahead of bar screens at the intake structure. The chlorine prevents buildup of algae in condenser tubes and in the circulating water system.

The smaller photo shows more pipe of Geon circulating salt water to cool the bearings of circulating water pumps. Geon is not affected either by salt water or most chemicals—which proves its value in still another part of this large generating station.

Geon is used to pipe the acid bearing (H_2SO_4) wash-down water from the boiler waste hopper to the discharge canal. Geon piping is used also for pumping salt water to the soot disposal collectors.



Geon pipe and conduit also provide high impact and tensile strength. Both are lightweight, easy to install. They are examples of the way that versatile Geon provides the key to new and improved products or applications. For information, write Dept. AH-2, B.F. Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

B.F.Goodrich Chemical Company
a division of The B.F.Goodrich Company

B.F.Goodrich

GEON polyvinyl materials • HYCAR American rubber and latex
GOOD-RITE chemicals and plasticizers • HARMON colors

New floating "Pooltex"® mesh pool cover woven of Reevon yarn made from Marlex resin and ultra-violet stabilized by Reeves Bros., Inc., N.Y.C., is so light one person can carry it—so tough three people can stand on it! This new cover keeps pools clean... lets rain pass through, but keeps out leaves, insects, etc.—helps protect pool owner from danger of children falling in!

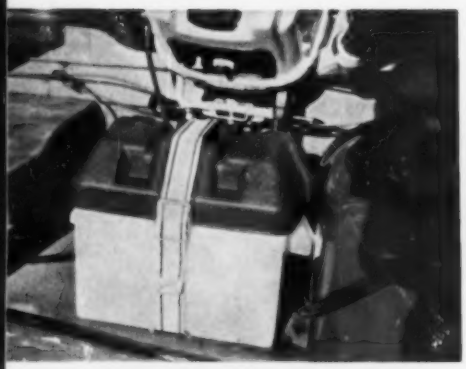
Get in the swim—with water sports products made of MARLEX*...the tough, rot-proof, floating plastic!

Cash in on profitable water sports markets with new idea products made of MARLEX, the linear polyethylene that is so strong and tough it can be used for tugboat hawsers, yet so light it actually floats.

You can soak products molded from MARLEX in salt water for long periods, and they won't absorb a drop of water or show the least sign of corrosion or discoloration. And they won't crack or break at temperatures from −180° to +250° F!

In fact, no other type of material can serve so well and so economically in so many different applications. How can MARLEX serve you?

*MARLEX is a trademark for Phillips family of olefin polymers.



Sinko Mfg. & Tool Co., Chicago, Ill., offers this new "Sea Guard" battery case that is impervious to acids, salt air and water. This new unbreakable case made of MARLEX withstands both high and low temperatures . . . holds all standard 6 and 12-volt marine batteries.

Fishing tackle boxes injection-molded from MARLEX by Plano Molding Co., Plano, Ill., are lightweight, rugged and corrosion-proof. These unbreakable tackle boxes will not crack or dent, and are completely weather-proof. Their attractive finish is durable and scratch-resistant.

Many leading manufacturers offer rope made of MARLEX to the marine market for ski tow ropes, hawsers, shrouds, life lines, heaving lines and general usage. Unbreakable, unsinkable rot-proof handles for ski tow ropes are molded from MARLEX by Lock-Hauer Co., Portland, Ore.

PHILLIPS CHEMICAL COMPANY, Bartlesville, Oklahoma

A subsidiary of Phillips Petroleum Company

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